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BRAZIL: ECONOMIC STUDY OF CASSAVA

Demand Studies in Brazil

Introduction

Brazil is the world's largest cassava producer with a total production comprising 16% of world production and close to 80% of Latin American production. Historically cassava has played a fundamental role in Brazil as a source of carbohydrates for human consumption and as a source of employment and income in the poorer rural areas especially in the northeast. It has certain inherent characteristics that have made it an important crop grown in all areas of Brazil: it has very high productivity per unit land area; it is well adapted to adverse climatic and soil conditions; it has no fixed planting date or time of harvest; it can be harvested when needed over a long period of time; and it rarely fails as a crop.

In the last 15 years however the rate of increase in cassava production has not kept up with rapid urbanization and industrialization. Cassava production and utilization patterns have not changed to meet the new requirements of an urban, industrial society. This trend has been aggravated by government policies that have favored export crops such as soy and grain crops at the expense of traditional staples such as cassava and beans. These trends are disturbing as they have had potentially negative effects on the nutritional level of the poorer segments of the population and the income level of the small farmers who produce these staples.

In order to understand how cassava will fit into the agroeconomy of Brazil in the coming years it is necessary to analyze the production processing and marketing of cassava.

The diversity of climatic, edaphic, and social conditions in Brazil is great, ranging from the tropical rain forest of the underdeveloped northern region, through the very poor semi-arid areas of the northeast to the subtropical and relatively advanced southern states. These differences indicate that no single study can adequately cover this variability and hence the studies presented in this document are on a regional basis.

Objectives

The objective of these studies is to determine how cassava can fit into the Brazilian agricultural economy in the future in such a manner that it assists the country in reaching policy goals such as improved welfare of the rural community and increased availability of low-priced food to the population as a whole.

The specific objectives of the study are:

1. Analyze the current and potential role of cassava for human consumption with special attention to the country's nutritional policies.

2. Evaluate the income generation and employment opportunities created by cassava production and processing.

3. Describe the current and potential incorporation of cassava into animal feed.

4. Identify the regions where cassava production can be expanded and the markets which it will enter.

Information sources

This study is based on two principal sources of information. Firstly the demand side analysis is based on the Instituto Brasileiro de Geografía e Estatísticas (IBGE) Survey of household expenditure and consumption. In order to avoid bias caused by grouping of the data in the published reports, this analysis is based on the raw data obtained from the IBGE tapes. Secondly the supply-side analysis is founded on the EMBRAPA, EMBRATER, and CIAT farm survey carried out on 1200 farms. These farms where carefully selected using modern statistical-sampling techniques to ensure an adequate coverage of the wide range of conditions encountered in Brazil. In this manner it is felt that interpolation can be made to areas not covered in the survey. The survey data where collected in Rio Grande do Sul, Santa Catarina, Parana, Minas Gerais, Bahia, Pernambuco, Maranhao, and the Federal Territory of Parana.

Document layout

This first chapter serves as the introduction to the studies. The second chapter briefly summarizes the recent developments in the Brazilian agricultural sector with special emphasis on agricultural policies and on the balance between food production and exports.

The third chapter analyzes trends in cassava for human food and its future potential role. The fourth chapter turns to an analysis of the rapidly expanding animal feed industry and the fifth chapter looks at the supply side concentrating on production and processing aspects.

The sixth chapter concentrates on the cost structure of cassava production and processing and sets this in the framework of cassava's future role as a source of rural income and its contribution to food and feed supply.

Finally in chapter seven conclusions and recommendations are presented.

Special terminology

In this document the use of the word "farinha" is used for the special toasted cassava meal or flour used throughout Brazil. The word "aipim" is used for cassava that is eaten in the fresh form. This cassava is sweet, with a low HCN level as opposed to the roots used in the production of farinha or starch.

Agricultural Policy in Brazil

1950-1963

In the fifties and the early years of the sixties economic development policies were directed to stimulating the growth of the industrial sector and the substitution of manufactured imports. In order to achieve this policy goal, policies favored the industrial sector at the expense of the agricultural sector.

The cruzeiro was overvalued, food prices were controlled at low levels, and agricultural exports were restricted. These policies were coupled with the freezing of urban salaries, strict control of the price of basic agricultural products, and restrictions on the importation of agricultural inputs. These policies, which were designed to increase the rate of growth of the industrial sector, restricted the growth of the agricultural sector due to a negative effect on demand (e.g., through low salaries in the urban sector) and also to problems on the supply side (e.g., lack of availability of inputs).

These negative effects were to a certain extent mitigated by subsidies to fertilizers and other inputs for grain crops and traditional export crops such as coffee. Furthermore, the large areas of unexploited frontier lands and low-cost rural labor allowed the agricultural sector to subsist and even expand during this period.

1964-1972

In this period policies began to change in a manner that favored the agricultural sector. The cruzeiro was subject to a series of small devaluations; quality control on exports of agricultural goods were relaxed and other tariff barriers were reduced. In addition the price controls on food products were reduced and subsidized credit was made available to the agricultural sector. This credit beared negative real interest rates and compensated for the high price of agricultural inputs and the high price of rural labor that resulted from the rapid rural to urban migration in this period. Cheap credit and high labor costs resulted in rapid mechanization and increases in the use of inputs. This change occurred in those crops that responded to mechanization and heavy use of inputs--principally, crops that were grown by the farmers in the richer southern states. Thus crops such as soy were favored over the traditional crops such as tree cotton, cowpea, and cassava grown in the poorer states of the northeast.

On the demand side a series of factors began to stimulate the agricultural sector. World prices for agricultural prices were high thus making export an attractive option. It was at this time that the exportation of soy bean began to grow rapidly. Internally the growth of the industrial sector created increased purchasing power in the urban sector with its positive impact on the demand for agricultural products.

In addition the government indicated that the future development of Brazil lay in the vast unexploited central western region and established the city of Brasilia in this area. This region developed rapidly whist the northeast in spite of its high population and low level of development was largely neglected and did not share in the development taking place in the rest of Brazil.

1973-1979

The oil crisis in the early seventies renewed the fears of excessive dependence on the state of the world economy. To this was added rapid inflation. These two factors induced the government to adopt measures that tended to decrease imports and increase the exports from the industrial sector. Once again this provoked a new recession in the agricultural sector. In order to compensate, the policies for subsidized credit were maintained and there was a rapid increase in the research and extension efforts in the agricultural sector. Minimum prices were established for certain agricultural products and the wheat subsidy program was initiated. All these measures tended to favor the richer southern states and the larger farmers.

The overall economic development of Brazil was rapid in this period due to the rapid increase in manufactured exports, and easy access to international credit.

1980-1984

Repeated cuts in the supply of petroleum products by OPEC and the resulting increases in oil prices coupled with fears about protectionism in the developed countries reinforced Brazilian consciousness of their vulnerability to external factors that effect their development process. This was further increased by the enormous external debt and high interest rates. The government turned to the agricultural sector to assist in alleviating the critical economic situation in which the country found itself. The production of alcohol to replace imported oil was a component of this policy.

In addition, for the first time the government began to turn to the objective of stimulating the production of food crops (other than wheat which was subsidized heavily in the seventies) rather than seeing the agricultural sector mainly as a means of reducing the balance of payment deficits through export crops.

1985-1986

In 1985, the civilian government was installed in Brazil. This has brought with it an increased awareness of social goals in the formation of policies. Of particular concerns are the low nutritional level of millions of people, the low level of development in the North East, the skewed distribution of land holdings, and the ravages of the rampant inflation that has plagued Brazil in the last decade. The agricultural sector is seen as critical in reaching more equitable development in Brazil in the coming years.

As a result the government has set the target of improving the nutritional situation through increased production of food crops; rice, beans, cassava, and maize have been set as priority crops. Credit will be expanded in such a manner that the small- and intermediate-sized producer (traditionally the major food producer) have access to it. As a further stimulus to the producer the minimum price policy has been reactivated. Furthermore, the government is committed to a land-reform program that will be supported by integrated rural-development projects. Whilst in the past emphasis has been on the export crops in the south, present policies are geared to developing the agricultural frontier and the so often neglected northeast. This program will not only concentrate on the production side but will also assist in the development of infrastructure, education, marketing, and other aspects necessary for the development of the region. A special program has been established for this area with support from the Ministry of Irrigation to facilitate the rapid implementation of irrigation projects in the area. These are expected to be of the order of US$19 billion over the next 15 years.

At present these policies are to a certain extent negated by the rigid price controls that form part of the temporary plan Cruzado that has drastically reduced inflation. Nevertheless the present policies favor the food crops such as cassava that are produced by the smaller farmers in a manner that is unique in the recent history of Brazil.

Human Cassava Consumption

Demand estimations

Consumption and expenditure surveys are very scarce in Brazil, mainly because they are quite costly and take a lot of human resources for a reasonable job. Given the lack of time-series data on patterns of consumption and expenditure on food, the most common alternative to analyze the effects of policy changes and other structural changes over food consumption patterns over time is through estimation of demand functions which relate quantity consumed to relative food prices, income, and other socioeconomic indicators. Indeed, several demand estimations had been done in the past based on the ENDEF study (i.e., A.F. Filho, 1980; C.W. Gray, 1982; P. Musgrove, 1986). Unfortunately, there exist some problems with these studies that limits their use for our work. First, most of them are based on the aggregate data reported in the ENDEF publications (C.W. Gray, 1982). Second, the commodities studied are in highly aggregate groups (M. Wuelfinghoff, 1980), that does not relate to our specific purposes. And third, some studies just refer to one region (A.F. Filho, 1980; P. Musgrove, 1986).

The present research overcomes these three limitations. In order to avoid bias problems caused by the grouping of data in the ENDEF reports, this study uses as data the raw data on consumption and expenditures by individual families, obtained from the IBGE tapes. Because of the objectives of the present study, we will only concentrate on the individual demand of three food commodities: cassava flour, wheat, and rice. Finally, the analysis is done on a regional basis, and urban and rural locations.

The consumption model

Several behavioral demand functions have been reported in the literature. The most-widely used and best known are the log-linear, the double-log, and the double-log quadratic form of the Engel function. One limitation of the first two is that the income elasticity of a particular food is constant regardless of the income level of the consumer. Timmer and Alderman (1979), first used the double-log quadratic to test the consistency of income elasticity, and since then it has been widely used by other studies to overcome this particular problem.

There has also been the argument that demand-price elasticities vary among different income groups, and unless one applied these functional forms individually to each income group they are not useful to test this hypothesis. Use of this method however, is very limited depending on the possibility of having a large number of observations for every income stratum. Philip Musgrove (1986), solved this problem by using the double-log form and adding a new term to the right-hand side of the model, N*P/E, which he labeled the "inverse of maximum per capita consumption," where N represents the number of persons in the family; P, is the price of the particular food; and E, is the expenditures of the family, used to represent income. Therefore, this allows both the income and price elasticities to vary at different income levels.

Certainly it is commonly agreed upon among economists, that demand functions should be estimated accordingly to demand theory. That is, the demand for a particular commodity is a function of its own price, the vector of prices of other commodities, the income of the consumer, and other characteristics representing the taste and preference of the consumer. As mentioned above, however, there is no agreement on the functional form. Perhaps, the most reasonable approach, would be to use the translogaritmic (or translog) demand function developed by L.R. Christensen, D. W. Jorgenson, and L. J. Lau (1973), which is interpreted as a second-order approximation to any demand function. Our plan is to use this flexible function, which places no restrictions on the price and income elasticities, in such a way that we allow them to vary at different income levels, and at the same time, we don't make any arbitrary assumption about the true functional form. That is, a second order approximation to any fuction is:

$$Y = f(X),$$

where,

$X = (x_1, x_2, \ldots, x_n)$, is the Taylor Series Expansion,

such that,

$$Y(X) = f\,(x^*) + \sum_{i=1}^{n} \left.(df/dx_i)\right|_{x^*} (x_i - x_i^*)$$

$$+ 1/2 \sum_{i=1}^{n} \sum_{j=1}^{n} (d^2f/dx_i dx_j)\Big|_{x^*} (x_i - x_i^*)(x_j - x_j^*),$$

where,

$X^* = (x_1^*, x_2^*, \ldots, x_n^*)$ is the point around which Taylor's approximation is taken.

Therefore, our translogaritmic demand function will be:

$$\ln Qs = Bo + \sum_{i=i}^{4} Bi \ln Xi + ½ \sum_{i=i}^{4} \sum_{j=i}^{4} Bij\ (\ln\ Xi)(\ln\ Xj)$$
$$+\ Bn\ (\ln N) + \text{the error term},$$

for all (s = 2,3,4) and (i,j = 1,2,3,4)

where,

$Bo = f(x^*)$

$Bi = (df/dxi)\Big|_{x^*}$

$Bij = (d^2f/dx_i . dx_j)\Big|_{x^*} = (d^2f/dx_j . dx_i)\Big|_{x^*} = Bji$

and Bij = Bji are imposed by the equality of cross-partial derivatives in a quadratic equation where:

Qs = is the quantity consumed of the good s-th by the family,

X_1 = is the annual money expenditures of the family, used as a proxy for family income,

X_2 = is the price of rice,

X_3 = is the price of wheat,

X_4 = is the price of cassava flour, and

N = denotes the size of the family, which is measured in adult-units.

(from now on let's denote the subscipts (1,2,3,4) as m=for money income; r=for rice, w=for wheat; f=for cassava flour).

Here, both family expenditures and food prices, were transformed into real values (Cr$ of 1977), enabling us to make inferences about income and prices changes over time. The family size was included in the model as another plausible variable affecting the family-consuming behavior. In statistical terminology, the parameter, B_n, will affect only the estimation of the intercept.

The income elasticity for the particular food, is defined as:

$$E_{Qi,\,I} = d(\ln Q_i)/d(\ln I) = B_m + B_{mm}(\ln I) + \tfrac{1}{2}\sum_i Bmi\,(\ln Pi),\ \forall : (i \neq m \ \&\ i=r,w,f)$$

The own-price elasticity, is defined as:

$$E_{Qi,Pi} = d(\ln Qi)/d(\ln Pi) = Bi + Bii\,(\ln Pi) + \tfrac{1}{2}\sum_j Bij\,(\ln Pj),\ \forall : (j \neq i \ \&\ i,\ j=r,w,f)$$

The cross-price elasticity, is defined as:

$$E_{Qi,Pj} = d(\ln Qi)/d(\ln Pj) = Bj + Bjj\,(\ln Pj) + \tfrac{1}{2}\sum_i Bij\,(\ln Pi),\ \forall : (i \neq j \ \&\ i,j=r,w,f)$$

This model was applied to each individual family observation obtained from a subsample of 2000 observations from the IBGE tapes. In order to keep the most possible homogeneous consumer groups, the observations were classified by region, and urban and rural location. This classification was shown to be useful, since there clearly exists a wide difference in taste and preferences among regions and urban-rural locations of Brazil. Finally, because the ENDEF survey was applied to each household over a period of only one week, some observations had missing data on the consumption of a particular food and/or its own price. To overcome this problem, it was decided to use only those observations that show consumption for the particular food that was being analyzed. With respect to the problem of the missing prices, it was resolved to use the zero-order regression estimators method (J. Kmenta, 1971), which reduces to use the average value for the missing independent variable, so that the parameters estimated remain unbiased and do not affect variance.

The estimation results

Tables 1, 2, and 3 contain the parameter coefficients estimated for the translog demand functions. The number of observations for different commodities varies because of the missing data problem mentioned above. In general the F-values and the standard errors are significant at the 5% confidence level for most of the regressions, with some exemptions in the parameters corresponding to the cross price products (Bij's). This was expected because of the little variation in relative food prices that is often found in cross-sectional data. As was also expected, the estimations for the parameter (Bn) were statistically significant in all of the regressions, clearly reflecting an increase in food consumption with increases in the family size.

Income and price elasticities, were calculated on the basis of minimum salary groups, where one minimum salary in the year 1975--when the ENDEF survey was applied (in real values of 1977)-- was equal to Cr$841.43 in the northeast, Cr$996.17 in the southeast, and Cr$1073.54 in the south. Elasticities estimated for rice, wheat, and cassava flour, are reported in tables 4, 5, 6, and 7. Lets make some general remarks with regard to these elasticities, and their implication to some nutritional policy issues, such as, income transfers and price subsidies.

First, the income elasticities for the three food products, among the lower income brackets tend to be rather small (less than 1), meaning that the demand for these commodities increases proportionally less than increases in income. Indeed the ENDEF data suggest that people tend to increase the variety of their meals as income increase. This means that even though there exist deficits in calorie intake particularly among the poorest, increases in their income will result in a tendency to increase their demand for more expensive foods, like meats for example (as it has been shown in past studies; i.e., C.W. Gray, 1982; P. Musgrove, 1986). The ENDEF data show that the need to increase nonfood items (i.e., clothing and housing) is as important as an increase in food quality. Therefore, any policy related to direct income transfers with the goal to increase calorie consumption among poor people, may be

Table 1. Regression estimates for cassava flour, Brazil.

	South		Southeast		Northeast		North
	Urban	Rural	Urban	Rural	Urban	Rural	Urban
Observations	89	44	140	62	143	413	29
R-sor	0.4044	0.4519	0.4608	0.247	0.4138	0.3084	0.82
F-value	3.30	1.54	7.06	1.01	5.97	11.80	3.94
Aver. prices:							
Rice	1.83	1.80	2.17	1.90	1.92	1.96	2.15
Wheat	2.06	1.67	2.94	2.36	2.48	2.50	2.38
Cassava flour	0.80	0.82	1.03	0.81	0.75	0.76	1.71
Bo	-4.1781	-32.7346	9.3619	-16.4418	-1.5132	1.5349	-23.8125
(std error)	(9.0873)	(21.8507)	(12.0260)	(28.2733)	(4.7059)	(3.2265)	(17.2601)
Bn	0.9879	1.1682	1.2707	1.1085	0.8233	0.8013	1.0515
(std error)	(0.2839)	(0.4596)	(0.1698)	(0.4730)	(0.1317)	(0.0845)	(0.2238)
Bd	1.5309	6.2600	-1.7337	4.1352	2.1214	1.5373	4.9142
(std error)	(1.5132)	(3.4775)	(2.0011)	(4.9519)	(0.8364)	(0.5270)	(2.7373)
Br	-1.5886	11.1366	2.7484	12.1303	5.9426	0.2616	3.9042
(std error)	(10.5569)	(23.1493)	(7.8935)	(15.2631)	(4.1520)	(2.9091)	(16.4005)
Bw	4.5854	7.3554	6.0256	-4.0901	-9.2365	-5.2792	10.9881
(std error)	(3.7788)	(10.5005)	(5.5814)	(11.4706)	(4.1717)	(2.3704)	(10.7977)
Bf	-1.5987	-9.7008	-6.4366	-3.4660	-0.2698	-0.4315	-0.1120
(std error)	(5.5193)	(14.6257)	(3.9304)	(12.3416)	(1.8049)	(1.0534)	(10.0258)
Bdd	-0.1065	-0.4616	0.2165	-0.3206	-0.2652	-0.2365	-0.3887
(std error)	(0.1441)	(0.2766)	(0.1877)	(0.4381)	(0.0929)	(0.0562)	(0.2651)
Brr	3.9485	9.9497	-3.0412	13.9185	-0.6677	-0.0368	-7.2212
(std error)	(4.6058)	(13.4288)	(3.5100)	(7.5162)	(0.4703)	(0.3984)	(9.2557)
Bww	2.8707	5.1237	-3.7459	4.8060	2.9465	-1.2836	-5.5389
(std error)	(1.6821)	(3.7164)	(1.5814)	(2.6063)	(2.3260)	(0.8517)	(4.8236)
Bff	-0.8728	3.0834	-0.8451	1.4840	-0.1595	-0.2704	-6.2628
(std error)	(1.7931)	(3.6110)	(1.0526)	(4.0013)	(0.5622)	(0.2792)	(4.8554)
Bdr	-0.5383	-3.7066	-0.9994	-4.3447	-1.3172	-0.2482	-0.7340
(std error)	(1.9285)	(4.1385)	(1.3306)	(3.2707)	(0.6949)	(0.4975)	(2.9595)
Bdw	-1.7169	-2.0038	-1.1601	-0.3752	1.2856	1.2084	-1.9024
(std error)	(0.7054)	(1.9269)	(1.1249)	(1.9214)	(0.7349)	(47.5200)	(1.9097)
Bdf	0.7539	2.8702	0.1746	0.9165	0.0815	0.1180	-0.4738
(std error)	(1.0266)	(2.5742)	(0.6802)	(2.5458)	(0.3109)	(0.2127)	(1.7191)
Brf	-4.5041	-4.7233	11.4219	1.3869	-0.5342	-1.6287	12.7615
(std error)	(8.1634)	(33.3785)	(3.3274)	(8.6885)	(1.6818)	(1.1822)	(11.8394)
Brw	6.0007	-1.1759	11.7837	4.4122	1.5069	2.0955	6.0958
(std error)	(5.5055)	(10.0635)	(6.4244)	(10.9203)	(3.9913)	(2.2930)	(12.1477)
Bwf	-5.3674	-11.7992	1.7981	-2.3920	-1.3712	-0.2802	1.3931
(std error)	(2.5140)	(7.1276)	(2.6599)	(8.7573)	(2.3632)	(0.9050)	(5.8766)

Table 2. Regression estimates for wheat, Brazil.

	South		Southeast		Northeast		North
	Urban	Rural	Urban	Rural	Urban	Rural	Urban
Observations	123	157	423	174	427	191	31
R-sor	0.509	0.4721	0.5137	0.4728	0.5306	0.3039	0.8885
F-value	7.39	8.40	28.66	9.44	30.97	5.09	7.96
Aver. prices:							
Rice	1.81	1.80	2.17	1.90	1.96	1.95	2.15
Wheat	2.36	1.67	2.94	2.36	2.50	2.58	2.38
Cassava flour	0.72	0.82	1.03	0.81	0.76	0.71	1.71
Bo	-0.2480	-4.9736	-12.5351	-5.6493	-5.9903	-9.0911	1.2003
(std error)	(4.7312)	(5.8638)	(3.5376)	(6.7106)	(3.1483)	(9.4965)	(10.5508)
Bn	0.6959	0.3059	0.6652	0.6260	0.2727	0.3685	0.7295
(std error)	(0.1154)	(0.1371)	(0.0450)	(0.1411)	(0.0784)	(0.1501)	(0.1563)
Bd	1.7919	1.9466	3.0821	1.7367	1.3866	1.8485	0.3622
(std error)	(0.8412)	(1.0544)	(0.6195)	(1.1572)	(0.5319)	(1.6931)	(1.5220)
Br	-3.4238	1.1393	0.4415	-4.6266	0.9259	6.2973	5.0793
(std error)	(4.2830)	(4.7508)	(2.5193)	(5.9105)	(3.0215)	(8.9778)	(10.8597)
Bw	-3.1924	-1.9773	0.5379	0.5272	3.5274	2.4206	-4.4090
(std error)	(1.9175)	2.0640	(1.6560)	(2.3901)	(1.8943)	(3.1722)	(4.8455)
Bf	7.5952	-9.6428	1.0565	-9.1881	2.4007	-0.9093	-0.5917
(std error)	(4.3522)	(7.8165)	(1.9579)	(5.1193)	(1.3103)	(3.0769)	(6.7394)
Bdd	-0.1955	-0.1459	-0.2476	-0.1520	-0.0579	-0.0712	0.1016
(std error)	(0.0868)	(0.1033)	(0.0614)	(0.1088)	(0.0567)	(0.1828)	(0.1395)
Brr	0.0797	-1.8561	-0.0144	-1.0862	-1.1593	-2.1904	5.5720
(std error)	(2.1668)	(1.4035)	(0.4442)	(3.0897)	(0.4073)	(2.5281)	(6.4174)
Bww	-0.6386	-1.6949	-0.1981	-1.3816	-1.9473	-1.0525	0.2402
(std error)	(0.5078)	(0.7916)	(0.6419)	(0.5488)	(0.6999)	(0.8938)	(2.7959)
Bff	-1.7854	-2.7471	-0.0949	0.0288	0.1486	0.6433	4.6072
(std error)	(1.9737)	(1.9556)	(0.4779)	(1.6124)	(0.3206)	(0.5777)	(3.2272)
Bdr	0.5510	-0.2819	-0.1655	1.0702	0.1371	-1.2372	-2.2303
(std error)	(0.7632)	(0.9265)	(0.4731)	(1.2093)	(0.5516)	(1.8193)	(1.9075)
Bdw	0.3331	0.2871	-0.2170	0.1065	-0.4359	-0.4646	-0.0652
(std error)	(0.3459)	(0.4098)	(0.3289)	(0.4517)	(0.3612)	(0.6738)	(0.7699)
Bdf	-0.6251	2.4058	-0.1709	1.6411	-0.5743	0.1671	-0.2359
(std error)	(0.7249)	(1.5271)	(0.3370)	(1.1462)	(0.2574)	(0.7101)	(1.1852)
Brf	-3.6031	-7.2080	-0.2185	-2.2443	1.2668	0.0099	-2.5670
(std error)	(4.4708)	(12.5190)	(1.6520)	(4.3830)	(1.3801)	(3.8831)	(7.2729)
Brw	-0.7054	1.6833	0.9779	1.3765	-1.6384	0.5723	8.3997
(std error)	(1.9698)	(1.5329)	(1.5911)	(2.0953)	(1.7858)	(2.7468)	(7.3948)
Bwf	-8.4319	2.1433	0.1042	3.2392	0.8617	1.9777	1.1721
(std error)	(2.7848)	(3.5075)	(1.3349)	(3.2114)	(0.9056)	(1.4916)	(4.0396)

able 3. Regression estimates for rice.

	South		Southeast		Northeast		North
	Urban	Rural	Urban	Rural	Urban	Rural	Urban
bservations	280	111	792	127	362	151	11
-sqr	0.3805	0.3147	0.5355	0.3974	0.3211	0.3301	
-value	10.81	2.91	59.64	4.88	10.91	4.43	
verage prices:							
ice	1.83	1.80	2.10	1.90	1.96	1.95	2.14
heat	2.06	1.67	2.82	2.36	2.50	2.58	2.07
assava flour	0.80	0.82	0.96	0.81	0.76	0.71	1.64
Bo	1.7738	-4.0124	-4.1560	-27.3292	-4.4727	-11.8834	
std error)	(3.1736)	(7.3930)	(1.7573)	(8.9034)	(4.6664)	(11.9005)	
Bn	0.8903	0.6227	0.9546	0.6698	0.6007	0.5606	
std error)	(0.0830)	(0.1825)	(0.0361)	(0.1763)	(0.0998)	(0.2110)	
Bd	1.1797	2.8619	1.9532	7.1052	1.0910	2.6845	
std error)	(0.5859)	(1.3659)	(0.3564)	(1.7538)	(0.8378)	(2.2182)	
Br	-3.0619	-6.4680	-2.6288	-9.4034	-0.2631	7.0696	
std error)	(2.2674)	(4.9827)	(1.2766)	(4.7290)	(2.5078)	(6.0501)	
Bw	-0.8006	-4.9790	2.3551	4.1205	7.2546	3.7806	
std error)	(1.2147)	(2.9968)	(0.8472)	(3.1101)	(3.0071)	(6.8428)	
Bf	6.6094	15.7217	1.1342	-2.7340	-0.7340	2.0432	
std error)	(2.9129)	(9.9990)	(1.1331)	(5.7819)	(2.1104)	(4.2967)	
Bdd	-0.1529	-0.3652	-0.1832	-0.7217	-0.0488	-0.2256	
std error)	(0.0586)	(0.1351)	(0.0394)	(0.1837)	(0.0870)	(0.2341)	
Brr	-1.0701	-0.4189	-0.4108	1.7206	-1.0586	-3.4917	
std error)	(0.9923)	(1.5447)	(0.3975)	(2.7248)	(0.3970)	(2.2939)	
Bww	-0.2024	-0.6997	0.3385	0.7529	-0.6831	-0.9695	
std error)	(0.4510)	(1.0584)	(0.3459)	(0.9217)	(1.0139)	(1.4145)	
Bff	-0.8308	2.1133	-0.1340	-2.7850	0.1887	0.8726	
std error)	(0.9106)	(2.1884)	(0.3734)	(1.6690)	(0.5179)	(1.1451)	
Bdr	0.4515	1.0705	0.4382	1.3009	0.2390	-1.0613	
std error)	(0.4231)	(0.9721)	(0.2462)	(1.0109)	(0.4531)	(1.2498)	
Bdw	0.3116	1.1802	-0.5831	-1.1055	-0.8997	-0.0656	
std error)	(0.2400)	(0.5791)	(0.1835)	(0.6294)	(0.5569)	(1.4680)	
Bdf	-1.1271)	-2.8852)	-0.5493	0.0901	0.0554	-0.4969	
std error)	(0.5408)	(2.0053)	0.2263	(1.2638)	(0.3752)	(0.8576)	
Brf	-7.0974	-4.7346	1.3179	-0.8023	-1.6480	-0.2134	
std error)	(4.1771)	(13.9998)	(1.1597)	(3.9505)	(1.1972)	(2.7059)	
Brw	-0.0328	1.2686	1.0558	3.4542	-4.6509	-4.9947	
std error)	(0.9703)	(1.6747)	(0.8171)	(2.2254)	(1.8799)	(3.1242)	
Bwf	3.4228	2.8383	0.0273	6.0404	2.6816	1.4046	
std error)	(1.3899)	(4.5447)	(0.8171)	(4.2238)	(1.6245)	(2.8267)	

Table 4. Price and income elasticities for fresh cassava[a].

	Fresh cassava			
	Northeast		South and southeast	
	Urban	Rural	Urban	Rural
Income elasticities (by salary class)				
SC= 1/2 minimum salary	2.7109	2.6529	2.6824	2.6228
1/2 < SC=< 1 minimum salary	2.5939	2.5297	2.5654	2.4991
1 < SC=< 2 minimum salary	2.4769	2.4056	2.4484	2.3755
2 < SC=< 5 minimum salary	2.3222	2.2421	2.2937	2.2120
Price elasticities				
Own price	-1.8776	-1.8776	-1.8776	-1.8776
Price of rice	-1.8968	-1.8968	1.8968	1.8968
Price of wheat	1.4937	1.4937	1.4937	1.4937
Price of potatoes	0.2442	0.2442	0.2442	0.2442

a. Model: Log Q = Bo+Log Inc+Log Sqr-Inc(1+dummy rural)
+sum (log prices)

R-sqr = .6077 and No.OBS=153

Where parameters estimated were:

	Intercept	Cassava	Rice	Wheat	Potatoes
Estimate	-18.8697	-1.8776	-1.8968	1.4937	0.2442
Std error	14.0865	0.3857	0.4117	0.2871	0.2594

	Income	Incom-sqr	Rural (INC-sqr)
Estimate	3.7308	-0.0844	-0.0048
Std error	1.4465	0.0376	0.0005

Characteristics:

a. Mean cells (for consumption and expenditure) as observations

b. Dummy variables were used for rural/urban areas

c. Double-Log function

ble 5. Income and price elasticities for rice.

	South		Southeast		Northeast		North
	Urban	Rural	Urban	Rural	Urban	Rural	Urban
come:							
/2 min salary	0.213	0.562	0.225	0.763	0.335	0.460	0.335
1 min salary	0.107	0.309	0.099	0.263	0.302	0.304	0.302
2 min salary	0.001	0.056	-0.028	-0.238	0.268	0.148	0.268
5 min salary	-0.139	-0.278	-0.196	-0.899	0.223	-0.059	0.223
8 min salary	-0.210	-0.450	-0.282	-1.238	0.200	-0.165	0.200
n price:							
/2 min salary	-0.949	-1.225	-0.508	-1.075	-1.861	-2.117	-1.861
1 min salary	-0.792	-0.854	-0.356	-0.624	-1.778	-2.485	-1.778
2 min salary	-0.636	-0.483	-0.204	-0.174	-1.695	-2.853	-1.695
5 min salary	-0.429	-0.008	-0.003	0.000	-1.586	-3.339	-1.586
8 min salary	-0.323	0.000	0.000	0.000	-1.530	-3.589	-1.530
ice of wheat:							
/2 min salary	0.028	-0.071	0.562	0.433	0.860	0.674	0.860
1 min salary	0.136	0.338	0.360	0.094	0.548	0.651	0.548
2 min salary	0.244	0.747	0.158	-0.334	0.236	0.628	0.236
5 min salary	0.386	1.288	-0.109	-0.840	-0.176	0.598	-0.176
8 min salary	0.460	1.565	-0.246	-1.100	-0.387	0.583	-0.387
ice of farinha:							
/2 min salary	0.554	0.986	0.472	0.456	0.144	0.048	0.144
1 min salary	0.163	-0.013	0.386	0.487	0.163	-0.124	0.163
2 min salary	0.163	-0.013	0.386	0.487	0.163	-0.124	0.163
5 min salary	-0.353	-1.335	0.272	0.529	0.188	-0.352	0.188
8 min salary	-0.618	-2.013	0.213	0.550	0.201	-0.469	0.201

ble 6. Income and price elasticities for wheat.

	South		Southeast		Northeast		North
	Urban	Rural	Urban	Rural	Urban	Rural	Urban
come:							
/2 min salary	0.486	0.419	0.745	0.631	0.818	0.579	0.283
1 min salary	0.351	0.318	0.574	0.526	0.778	0.530	0.354
2 min salary	0.215	0.217	0.402	0.420	0.738	0.481	0.424
5 min salary	0.036	0.083	0.175	0.281	0.685	0.415	0.517
8 min salary	-0.056	0.014	0.059	0.210	0.658	0.382	0.565
n price:							
/2 min salary	-1.104	-1.305	-0.239	-0.096	-0.785	-0.705	-0.949
1 min salary	-0.989	-1.206	-0.314	-0.059	-0.935	-0.866	-0.972
2 min salary	-0.873	-1.106	-0.389	-0.022	-1.087	-1.027	-0.995
5 min salary	-0.721	-0.975	-0.489	.000	-1.287	-1.240	-1.024
8 min salary	-0.643	-0.907	-0.540	.000	-1.389	-1.349	-1.040
ice of rice:							
/2 min salary	-0.671	-0.041	0.235	0.157	-0.194	-0.171	2.789
1 min salary	-0.480	-0.139	0.177	0.528	-0.147	-0.599	2.016
2 min salary	-0.289	-0.236	0.120	0.898	-0.099	-1.028	1.243
5 min salary	-0.037	-0.366	0.044	1.389	-0.036	-1.595	0.221
8 min salary	0.093	-0.432	0.005	1.640	-0.004	-1.886	-0.303
ice of farinha:							
/2 min salary	0,751	-0.116	0.282	-1.388	0.732	0.523	0.400
1 min salary	0.535	0.717	0.223	-0.820	-0.533	0.581	0.318
2 min salary	0.318	1.551	0.164	-0.251	0.334	0.639	0.236
5 min salary	0.032	2.653	0.085	0.501	0.071	0.715	0.128
8 min salary	-0.115	3.219	0.045	0.886	-0.064	0.755	0.073

able 7. Income and price elasticities for cassava flour.

	South		Southeast		Northeast		North
	Urban	Rural	Urban	Rural	Urban	Rural	Urban
ncome:							
/2 min salary	-0.2703	0.3236	-0.8612	0.3236	0.0026	-0.0254	0.3670
1 min salary	-0.3441	0.0037	-0.7111	0.0037	-0.1813	-0.1893	0.0976
2 min salary	-0.4180	-0.3163	-0.5610	-0.3163	-0.3651	-0.3532	-0.1719
5 min salary	-0.5156	-0.7393	-0.3627	-0.7393	-0.6081	-0.5699	-0.5280
8 min salary	-0.5656	-0.9562	-0.2609	-0.9562	-0.7327	-0.6811	-0.7107
wn price:							
/2 min salary	-1.3984	-2.1398	-0.3085	-2.1398	-0.6734	-0.5306	-0.0037
1 min salary	-1.1371	-1.1451	-0.2480	-1.1451	-0.6451	-0.4897	-0.1679
2 min salary	-0.8758	-0.1503	-0.1875	-0.1503	-0.6169	-0.4488	-0.3321
5 min salary	-0.5304	0.0000	-0.1075	0.0000	-0.5796	-0.3947	-0.5492
8 min salary	-0.3533	0.0000	-0.0664	0.0000	-0.5604	-0.3670	-0.6606
rice of rice:							
/2 min salary	1.1079	0.8977	2.5697	0.8977	0.6524	0.3622	1.3133
1 min salary	0.9213	-0.3869	2.2233	-0.3869	0.1959	0.2762	1.0589
2 min salary	0.7347	-1.6715	1.8770	-1.6715	-0.2606	0.1901	0.8045
5 min salary	0.4881	-3.3696	1.4191	-3.3696	-0.8641	0.0764	0.4683
8 min salary	0.3616	-4.2407	1.1742	-4.2407	-1.1736	0.0181	0.2958
rice of wheat:							
/2 min salary	1.5431	2.0210	1.5332	2.0210	.0000	-0.5599	0.7813
1 min salary	0.9480	1.3215	1.1311	1.3265	0.0550	-0.1411	0.1220
2 min salary	0.3530	0.6321	0.7291	0.6321	0.5006	0.2777	-0.5373
5 min salary	-0.4336	-0.2860	0.1976	-0.2860	1.0896	0.8313	-1.4089
8 min salary	-0.8371	-0.7569	-0.0750	-0.7569	1.3917	1.1153	-1.8560

inefficient in the sense that it will require huge ammounts of money transfers in order to make some impact on calorie intakes among these groups. Furthermore, the difficulties to clearly distinguish the target income groups when applying this type of policy, makes the problem even more difficult because as income increases, the elasticities estimated for these three foods were found to decrease and even became negative for the higher income brackets which may offset the original goal of raising the average calorie consumption of the whole population.

Second, own-price elasticities were found to be around 1 or higher than 1, for the lower income brackets in all regions, except for cassava flour in the northeast, where the product is traditionally consumed in high levels and hence a smaller reaction to changes in cassava prices is expected. This means that, apparently, there is a better chance to influence consumers' behavior through price subsidy policies than income transfers for increasing the consumption of these food staples particularly in the case of wheat, where the demand response was found to be very elastic to changes in its own price.

Finally, despite the small changes in relative prices that are often found in cross-sectional data, we were able to measure some degree of substitution among these three products. Particularly in the case of rice and cassava flour, we found that the demand cross-price elasticities for these products, with respect to changes in wheat prices are positive and close to 1, within the lower income groups in various regions of the country. This means that any price-subsidy policy directed to any of these products, should be analyzed not only with regard to its direct own-price effect, but also to its consequences over the demand for its close substitutes since there is clearly a risk, of affecting the overall level of calories consumed by the population via effects on their relative-price competitiveness.

The parameters estimated here will be used in the next sections to examine in greater detail these issues. Particularly in the case of our central concern, they are going to be useful for explaining some recent changes in the demand for cassava, which has been occurring over the last decade in Brazil.

Cassava for human consumption

A series of studies on nutrition in Brazil indicate that a large proportion of the population suffers from malnutrition. The World Bank (1979) study indicated that 58% of the population less than 17 years old suffers from malnutrition. In terms of people this translates into 19 million young people with first grade malnutrition; 10.5 million with second grade; and 0.5 million with third grade (Table 8). This malnutrition affecting a large part of the population, results in physical defects and mental retardation, and in severe cases in high levels of infant mortality.

Malnutrition is related to poor hygiene in the poorer areas, and a series of health-related problems. The major cause however, is simply the lack of sufficient calories in the diet of large sectors of the population. The IFPRI (1982) study indicated that the caloric intake

Table 8. Number (in thousands) and percentage of children under 17 years of age with first, second, and third degree of malnutrition by region, 1975.

Region	Degree of malnutrition					
	First		Second		Third	
	(No.)	(%)	(No.)	(%)	(No.)	(%)
North	2234	39.0	1131	23.3	42	0.7
Northeast	6332	38.2	4630	28.0	361	2.2
Southeast	10783	36.2	4581	15.4	44	0.2
Brazil	19349	37.2	10543	20.2	447	0.9

SOURCE: Gray, C. W. Food Consumption parameters for Brazil and their application to food policy. International Food Policy Research Institute. Research Report No. 32. September 1982.

was below minimum requirements in almost all regions of the country, with the greatest deficit in the north and northeast (Table 9). Furthermore, the situation is worse in the urban areas.

Cassava is a major calorie source in Brazil. The data of the IBGE survey (ENDEF) shows that rice and sugar were the two most important calorie sources in 1975, followed by cassava, beans, and wheat which are all about equally important. There are, however, regional differences. In the north cassava at 27% of the total calorie intake and in the northeast at 23% is the most important calorie source. The consumption is highest in the rural areas but still reaches levels of 290 calories per capita per day in the urban centers of the northeast and 465 calories per day in the north (Table 10). The tendency for higher consumption in the rural areas is found throughout Brazil.

Cassava is consumed in two principal forms in Brazil. First as farinha (a toasted flour) and second as aipim or fresh cassava. Per capita farinha consumption at 17.6 kg/year, as the national average, is much more important than aipim at 6.1 kg/year. The importance of farinha is also greater in the north and northeast regions at about 45 kg/year than in the south and southeast at 3.5-6 kg/year.

Consumption trends

The per capita consumption of cassava flour declined in the period 1960 to 1975 from 93 kg/year to 59 kg/year (Table 11). The decline was most pronounced in the south where the urbanization process has been most rapid in the last 20 years. The decrease in per capita consumption is related to two fundamental causes: the massive rural to urban shift resulting in altered consumption patterns, and the wheat subsidy reduced the price advantage of farinha over wheat flour.

The wheat subsidy. The production of wheat in the southern states is an attractive option for farmers who grow soy in the summer and wheat in the winter months. Both crops use similar machinery and do not compete for land or labor as they are planted in different seasons. Perhaps the factor that makes wheat so attractive is the high price. The government, concerned with the balance of payments, and wishing to reduce inflation and mantain low-cost food in the urban centers adopted the measure of subsidizing local wheat production. Wheat production is not easy in southern Brazil; yields are low and fluctuate widely from year to year. This results in enormous sums of money being required to sustain the policy goal of low consumer prices whilst at the same time inducing farmers to produce the crop. The World Bank estimates that the wheat subsidy is greater than US$1 billion in 1986 (recently "The Economist" quoted US$1.5 billion as the estimate for 1986). The form of the subsidy is such that the World Bank estimated that the consumers did not receive any effective subsidy in 1970, but by 1981 they recieved 90% of the subsidy (Table 12).

The role of the wheat subsidy was to break the link between producer and consumer prices, so as to maintain price incentives for domestic production and at the same time support lower prices to

Table 9. Average per capita daily calorie deficits by region and urban/rural location, (1975).

Region	Average consumption (calorie)	Estimated requirements[a] (calorie)	Calorie deficit (calorie)
Northeast			
Urban	1814	2150	336
Rural	2016	2145	129
North			
Urban	1750	2232	482
Rural[a]	1926	2226	300
South/ Southeast			
Urban	2127	2299	172
Rural	2445	2273	-

a. Taken from Cheryl Williamson Gray, "Food Consumption Parameters For Brazil and Their Application to Food Policy". International Food Policy Research Institute. Research Report No. 32. September 1982.

Table 10. Average per capita daily calorie consumption for each food by region and urban or rural location, 1975.

Foood Type	South and southeast			Northeast			North	Central West	Brazil		
	Urban	Rural	Total	Urban	Rural	Total	Urban	Urban	Urban	Rural	Total
Cereals	814.82	991.42	878.98	574.33	476.14	518.82	479.82	852.63	659.83	753.91	698.55
Rice	465.32	525.22	487.08	217.67	258.79	240.92	178.75	609.88	355.51	402.41	374.82
Maize	36.47	181.90	89.31	51.24	149.95	107.05	5.96	25.76	34.03	167.17	88.83
Wheat bread	195.53	50.31	142.77	252.03	54.36	140.27	249.31	150.96	185.13	52.18	130.41
Macarroni	68.12	56.42	63.87	36.37	7.45	20.02	33.52	40.87	50.91	33.85	43.89
Wheat flour	31.26	166.96	80.56	5.20	1.61	3.17	4.90	12.98	20.22	90.75	49.24
Roots and tubers	66.90	160.85	101.04	332.95	616.17	493.07	478.73	84.31	131.81	370.72	230.13
Potatoes	27.00	26.45	26.80	4.63	0.43	2.26	5.06	12.05	17.57	14.46	16.29
Fresh cassava	7.40	38.49	18.69	8.91	15.85	12.83	3.73	20.51	7.40	28.06	15.90
Cassava flour	25.24	77.98	44.40	293.45	572.16	451.02	465.93	40.90	96.23	305.76	182.46
Sugar	306.18	349.98	322.09	229.64	196.7	211.02	168.77	238.72	246.62	279.33	260.08
Legumes	178.74	281.90	216.22	214.29	404.9	322.05	101.11	181.17	163.70	338.59	235.68
Beans	171.27	266.89	206.01	190.78	346.2	278.65	94.49	175.04	153.66	303.45	215.30
Vegetables	27.52	21.89	25.47	12.55	8.48	10.25	8.69	20.75	20.15	15.71	18.32
Fruits	47.17	28.12	40.25	46.83	26.4	35.28	41.00	45.33	41.41	27.32	35.61
Meat and fish	193.87	159.89	181.52	200.30	162.69	179.04	262.30	173.18	174.30	161.18	168.90
Beef	87.44	36.17	68.81	103.68	52.8	74.91	129.75	101.03	83.03	43.84	66.90
Pork	33.94	61.24	43.86	34.16	53.8	45.26	17.10	31.87	29.46	57.81	41.13
Poultry	27.11	23.97	25.97	17.85	9.32	13.03	14.73	16.64	21.06	17.22	19.48
Dairy products	145.31	132.21	140.55	82.94	72.18	76.86	68.70	110.67	110.83	104.54	108.24
Oil and fats	322.84	302.42	315.42	105.72	45.9	71.90	121.44	328.14	232.00	184.18	212.32
Beverages	24.59	17.12	21.88	14.44	7.27	10.39	19.90	14.96	18.93	12.58	16.32
TOTAL	2127.93	2445.79	2243.42	1814.01	2016.83	1928.68	1750.46	2049.86	1799.58	2248.07	1984.15

SOURCE: ENDEF 1975, IBGE.

Table 11. Per capita cassava consumption (kg) in 1960 and 1975, Brazil.

	1960			1975		
Region	Fresh	Flour	Total	Fresh	Flour	Total
Northeast	7.1	55.2	172.6	4.3	43.7	135.4
Urban	.9	26.8	81.3	3.2	20.4	64.4
Rural	10.3	69.7	219.4	5.2	55.0	170.2
Southeast	11.8	17.0	62.8	4.5	5.9	22.2
Urban	4.4	6.4	23.6	2.0	2.7	10.1
Rural	20.2	29.0	107.2	5.0	14.1	47.3
South	44.6	12.1	86.9	15.8	3.5	26.3
Urban	3.7	5.2	19.3	7.6	2.5	15.1
Rural	68.7	16.2	117.3	23.2	4.4	36.4
Brazil	14.9	26.3	93.5	6.1	17.6	58.9
Urban	3.0	11.4	37.8	2.7	9.7	31.8
Rural	24.7	38.3	139.5	11.2	29.4	99.4

SOURCES: Fundação Getulio Vargas, 1979; Instituto Brasileiro de Geografía e Estatísticas (IBGE), 1978.

Table 12. Wheat subsidies (US$ millions) received by producers and consumers.

	Total subsidy (A)	Consumer subsidy (B)	B/A (%)	Producer subsidy (C)	C/A (%)
1968	36.6	16.43	44.9	20.12	55.1
1969	60.1	28.87	48.1	31.30	51.9
1970	33.3	-30.74[a]	0.0	64.05	100.0
1971	32.1	-60.11	0.0	92.23	100.0
1972	113.0	108.42	95.9	4.49	4.1
1973	222.8	248.71	100.0	-25.93[b]	0.0
1974	299.2	391.19	100.0	-92.05	0.0
1975	517.3	495.74	95.8	21.49	4.2
1976	424.6	377.20	88.8	47.36	11.2
1977	292.9	158.85	54.2	134.04	45.8
1978	707.1	705.53	99.7	1.56	.3
1979	828.4	760.52	91.8	67.74	8.2

a. Both government and consumers subsidized producers.

b. Both government and producers subsidized consumers.

SOURCE: World Bank, "A Review of Agricultural Policies in Brazil." September 1981.

consumers. Besides the great budgetary burden that this policy caused the government, there are also serious concerns with regard to wheat's nutritional effects, and for what location and to whom this policy helped. Because the wheat subsidy clearly affected the consumption levels of its close substitutes, such as rice and cassava, the balance of the combined calories consumed of these products have also been affected. The demand parameters discussed in this report, together with the average per capita daily calorie intake data obtained from the ENDEF survey, can be useful in analyzing the nutritional effects of this policy.

Based on the data collected by EMBRAPA on production costs and processing for wheat grains, wheat flour, bread, and macarroni the corresponding subsidy was obtained for these products. As reported in Table 13, the wheat subsidy reduced the price of bread (50 grams) to 27.48% and the price of macarroni to 29.6-32%. These figures, were weighed by the average expenditure shares on each wheat product by income groups and regions (Table 14), so as to calculate the wheat subsidy recieved by different income groups in different regions (Table 15). The effect of this subsidy in the per capita consumption for a given food commodity is given by:

$$DC_i = Co_i * [E_{iw} *. \text{ (wheat subsidy)}], \forall : (i = r, w, f)$$

where,

DC_i = change in calories consumed in food i-th due to the wheat subsidy,

Co_i = the amount of calories consumed of food i-th before the subsidy,

E_{iw} = the cross-price elasticity as defined before,

Hence the combined effect of the subsidy over the total calorie consumption of these three products, is given by:

$$DC_t = \sum_i DC_i, \quad \forall : (i = r, w, f)$$

The calculation results are reported in Table 16. It can be observed that the apparent effects of wheat subsidy over calorie intake widely differs and sometimes in a negative way for different sections of the population within and among regions. First, per capita consumption of rice and farinha decreased in all regions because of the wheat subsidy. Particularly, this substitution was strongly affected farinha

Table 13. Price subsidy (Cr$) for wheat bread and macaroni, Brazil.

Commodity	Production costs		Price	Subsidy (%)
	Flour	Other		
Wheat bread (50 g)				
with subsidy	0.074	0.306	0.38	27.48
without subsidy	0.218	0.306	0.52	
Macaroni (1 kg-comun)				
with subsidy	1.39	4.41	5.80	32.00
without subsidy	4.12	4.41	8.53	
Macaroni (1 kg-semola)				
with subsidy	1.78	6.52	8.30	29.66
without subsidy	5.28	6.52	11.80	

Table 14. Expenditures shares (%) on wheat bread and macaroni by regions and income group, Brazil.

Income group	South	Southeast	Northeast	North
Wheat bread				
Up to 2 min salaries	4.8	5.5	7.1	6.6
Between 2 and 5 min salaries	5.6	6.4	10.2	7.8
More than 5 min salaries	5.7	5.9	9.8	7.4
Macaroni				
Up to 2 min salaries	3.1	3.3	0.7	4.2
Between 2 and 5 min salaries	2.5	2.3	1.3	1.5
More than 5 min salaries	2.2	1.7	1.4	1.6

SOURCE: ENDEF, IBGE 1978.

Table 15. Wheat subsidy (%) received by region and income group, Brazil.

Income group	South	Southeast	Northeast	North
Up to 2 min salaries	29.3	29.2	27.9	29.2
Between 2 and 5 min salaries	28.9	28.7	28.0	28.2
More than 5 min salaries	28.1	28.0	27.8	27.9

SOURCE: Taken from Tables 13 and 14.

Table 16. Effects of wheat subsidy on daily calories consumed.

	South		Southeast		Northeast	
	Urban	Rural	Urban	Rural	Urban	Rural
Rice						
1 min salary	-18	-52	-49	-8	-33	-47
2 min salary	-33	-115	-21	51	-14	-45
5 min salary	-52	-195	15	127	11	-43
8 min salary	-60	-231	32	162	23	-42
Wheat						
1 min salary	85	97	27	5	77	15
2 min salary	75	89	34	2	89	18
5 min salary	61	77	41	0	106	22
8 min salary	53	70	45	0	113	24
Cassava flour						
1 min salary	-7	-30	-8	-30	-5	23
2 min salary	-3	-14	-5	-14	-41	-44
5 min salary	3	6	-1	6	-90	-133
8 min salary	6	17	1	17	-113	-177
Total						
1 min salary	60	14	-30	-33	39	-9
2 min salary	40	-41	7	39	34	-71
5 min salary	13	-112	55	133	27	-154
8 min salary	-1	-145	77	178	23	-195

in the northeast and rice in the south where these products are traditionaly consumed. Second, the direct effects of the subsidy over wheat consumption, apparently was favored more by rich people than the poor in the urban centers of the southeast and northeast. And third, the overall calorie intake increased in the south which has a relatively minor nutritional problem, while the subsidy effect was negative within the malnourished groups of the southeast, and a relatively small increase in the northeast.

In other words, because the own-price elasticity for wheat is apparently very elastic (greater or close to -1) in most regions, any subsidy in its price will likely cause a large substitution of traditonal calorie products, like rice, cassava, bread, and macarroni, so that the overall calorie intake by the malnourished may actually decrease. For nutritional purposes, the wheat subsidy policy certainly was not the most appropiate taken. Past studies, like the IFPRI 1982, show that a price subsidy on rice could be a more effective mechanism to raise the level of calories consumed by the poorest in the calorie-deficit areas of Brazil.

The wheat subsidy has obviously distorted the price structure for starchy staples and has affected the competitive ability of cassava. The demand cross-price elasticities for cassava with respect to the price of wheat were found to be positive, in particular for the lower income groups which indicates that wheat substitutes for cassava. In the period 1972 to 1980 the relative price of cassava flour to wheat flour increased (Table 17). As a result there has been substitution and the consumption of cassava flour (farinha) has declined. In the case of aipim (fresh cassava) the high-yield levels in the south have enabled fresh cassava to mantain its price relative to wheat even when this was falling due to subsidies. As a result, consumption of aipim has increased in the south. In the north and northeast, however, the relative price of both aipim and farinha has increased and this has obviously led to substitution of wheat for cassava.

In 1980 the government, concerned with the high cost of the wheat subsidy, began to slowly reduce the level. As a result there has been a slight tendency for the price of cassava relative to wheat to decrease (Table 17). At present, the government is in the position of being committed to reducing the wheat subsidy, however, at the same time it wishes to reduce inflation. Wheat plays an important part in the determination of the consumer price index and although reducing the subsidy is an economic necessity, it may well be politically difficult.

<u>The rural-urban migration</u>. Urbanization has been extremely rapid in Brazil. The population census of 1960 and 1984 show the urban population rising from 48.6% to 72.4%. Consequently, there has been a shift to the consumption of more convenient food sources. At the same time new marketing channels have been developed and a more varied diet is available.

The consumption of farinha on a per capita basis has declined over the last 15 years. This is partially due to urbanization, since urban consumption per capita is three times as low as rural consumption.

Table 17. Relative price (5-year moving average) of cassava.

Period	Porto Alegre		Sao Paulo		Rio		Salvador		Fortaleza	
	Flour	Root	Flour	Root	Flour	Root	Flour	Root	Flour	Root
				(5-year moving average)						
69/73	0.56		0.68		0.57	0.44	0.86	0.58	0.52	0.31
70/74	0.61		0.72		0.61	0.44	0.86	0.58	0.58	0.31
71/75	0.74		0.88	1.14	0.69	0.47	1.04	0.55	0.61	0.32
72/76	1.04	0.96	1.24	1.42	0.99	0.64	1.36	0.55	0.72	0.34
73/77	1.22	0.85	1.44	1.37	1.25	0.77	1.49	0.68	0.87	0.39
74/78	1.38	0.86	1.60	1.36	1.17	0.75	1.62	0.79	0.97	0.44
75/79	1.60	0.97	1.78	1.43	1.12	0.80	1.95	1.11	1.15	0.64
76/80	2.10	1.12	2.09	1.64	1.03	0.65	2.25	1.42	1.54	0.93
77/81	2.02	1.10	1.93	1.58	0.66	0.44	1.80	1.37	1.68	1.04
78/82	1.86	1.07	1.78	1.50	0.45	0.24	1.70	1.15	1.64	1.03
79/83	1.76	1.05	1.66	1.46	0.57	0.34	1.53	1.07	1.61	1.00
80/84	1.72	0.91	1.61	1.29	0.82	0.35	1.39	0.85	1.61	0.92

SOURCE: Anuario Estadistico, IBGE.

Nevertheless, analysis of urban farinha demand shows some interesting features. The demand for farinha calculated at constant prices has apparently increased in the urban areas. This is of great importance as the urban centers are those that face the greatest nutritional problems. How has this increase in demand occurred?

In the lower income groups the demand for cassava increases as incomes rise (i.e., it is a normal good). This is very plausible as the lower income groups do not have sufficient resources to meet their basic nutritional requirements. As their income increases they will purchase basic food such as farinha. The overall income elasticity is indeed negative; richer people want a more varied diet. The natural tendency is to interpret this fact as indicating that there will be a decrease in demand as income rise. This neither takes into account the differences in income elasticity in different income groups nor the overall increase in the population and the segments of the population in which this occurs.

In the last 15 years in Brazil the lowest income groups are those that are increasing most rapidly. The percentage of the population with income less than the minimum salary increased from 17% to 33% (Table 18). At the same time the urban population increased dramatically (Table 19). The average income levels also tended to increase (Table 20). The population increase, the income increase and distribution, and the farinha demand parameters estimated were combined in a model to predict the demand for farinha at constant prices. In Table 21 it can be seen that there was a substantial overall increase in the demand for farinha in the urban centers. The increase in demand takes place in the poorest segments of the urban population with the greatest nutritional problems. This increase in demand more than compensated for the decrease in demand in the richer segment of the population. Thus in the urban centers of the northeast demand increased from 139 thousand tons for the population with less than one minimum salary income level, in 1975, to 344 thousand tons in 1985. Similarly, in the lowest income groups of the urban centers of the south, demand increased from 13.4 thousand tons to 31.1 thousand tons. This indicates that if farinha prices can be maintained or reduced a substantial increase in total urban demand can be expected in the coming years.

With respect to fresh cassava, the low levels of consumption in the urban areas are apparently related to the inconvenient nature of this highly perishable product. This problem is illustrated by the fact that whereas over 90% of the farinha consumed in the urban areas enters through commercial markets only 55% of fresh cassava for human consumption follows this path (Table 22). Furthermore the marketing margins account for 80% to 90% of the final consumer price in the two major urban centers of Brazil (Table 23) due to the high risks involved in marketing fresh cassava. The price elasticity and the income elasticity for fresh cassava were found to be high. All the above stated facts indicate a buoyant demand for fresh cassava if the problem of perishability could be obviated. New fresh cassava conservation technology developed by CIAT has the potential to greatly reduce the perishability of cassava and also lower the price to the urban consumer thereby opening up the market for fresh cassava.

Table 18. Distribution (%) of people by salary class (SC) in 1976, 1981, and 1985.

Year	Salary Class (minimum monthly salary=1)					
	SC=<1	1<SC<2	2<SC<5	SC<5	Without response	Total
1976	16.93	25.07	31.84	25.13	1.03	100.00
1981	29.80	25.60	23.20	11.00	10.40	100.00
1985	33.00	22.60	22.30	12.10	10.00	100.00

SOURCE: FIBGE, "Anuario Estatistico do Brazil."

Table 19. Actual and estimated population, 1970-1990.

Population	Northeast Urban	Northeast Rural	Southeast Urban	Southeast Rural	South Urban	South Rural
1970	11723	16359	28965	10889	7303	9193
1976	14837	17985	36947	9540	9575	10462
1980	17586	17275	42848	8904	11881	7156
1983	20244	16988	47419	8609	12671	7275
1986[a]	22430	16745	53602	7011	14534	6398
1990[a]	26405	16591	62367	3732	17253	4852

a. Estimated.

SOURCE: FIBGE, "Anuario Estadistico do Brazil."

Table 20. Minimum salary by region[a], 1975-1985.

Year	General price index (%)	Northeast	Southeast	South
1975	49.63	841.43	996.17	1073.54
1976	70.10	859.34	1016.83	1095.58
1977	100.00	868.80	1027.20	1106.40
1978	138.74	1295.66	1518.81	1634.71
1979	213.53	1609.52	1964.41	1943.33
1980	427.47	1667.49	1980.21	1980.21
1981	897.30	1604.81	1850.89	1850.89
1982	1753.74	1744.84	1982.96	1982.96
1983	4463.80	2176.98	2176.98	2176.98
1984	14311.70	2327.61	2327.61	2327.61
1985	41160.74	1457.70	1457.70	1457.70

a. Real, base year = 1977.

SOURCE: FIBGE, "Anuario Estadistico do Brazil."

Table 21. Urban cassava-flour demand for urban areas (thousand t/yr) by income group.

Salary group	Northeast	Southeast	South
1975/1976			
1 min salary	114.28	48.18	10.83
2 min salary	119.92	27.70	6.09
5 min salary	139.00	23.31	6.02
8 min salary	58.54	14.00	2.70
1980/1981			
1 min salary	296.85	93.16	24.27
2 min salary	159.65	30.96	7.89
5 min salary	109.03	18.50	5.55
8 min salary	24.60	6.66	1.49
1985/1986			
1 min salary	426.07	149.72	37.51
2 min salary	187.63	39.74	9.74
5 min salary	146.20	25.93	7.47
8 min salary	38.95	10.69	2.30

Table 22. Fresh cassava prices (Cr$) at farm and retail levels in Sao Paulo and Rio de Janeiro, Brazil.

	Sao Paulo			Rio de Janeiro		
	Retail	Farm	F/R	Retail	Farm	F/R
1970				160.3	17.7	11%
1971	193	15.5	8%	195.4	27.7	14%
1972	204	22.2	11%	184.0	25.7	14%
1973	267	21.4	8%	197.8	24.3	12%
1974	317	20.2	6%	223.2	35.8	16%
1975	283	31.2	11%	244.8	55.2	23%
1976	301	59.3	20%	219.9	79.2	36%
1977	240	37.9	16%	206.5	75.5	37%
1978	217	16.6	8%	200.4	26.5	13%
1979	221	14.2	6%	200.8	33.6	17%
Average			10%			19%

SOURCES: Fundação Getulio Vargas; IBGE.

Table 23. Percent of cassava consumption that is purchased by urban and rural locations, 1975, Brazil.

	Cassava purchased (%)	
	Fresh cassava	Cassava flour
Central west		
Urban	39.22	74.18
North		
Urban	44.09	82.17
Northeast		
Urban	44.14	86.67
Rural	6.50	49.59
Southeast		
Urban	55.81	91.74
Rural	36.53	55.41
South		
Urban	42.26	95.52
Rural	2.19	73.14

SOURCE: IBGE. 1978.

The Market for Animal Feed Rations

Meat production

Brazil is one of the main beef producers in the world, and has a cattle stock of over 127 million animals. Although the south and the southeast together are the main beef producers, the central west is the single most outstanding beef production area. The northeast and the north have the lowest beef production figures (Table 24).

Beef, as well as swine production, has remained relatively stable over the last 15 years, with the exception of the central west region. The stagnant situation in beef and swine production is strongly related with the dynamic growth of the poultry sector within the same time frame.

Brazil is the world's third largest producer of poultry meat and produces some 7% of total world market supply. From the beginning of the seventies the poultry industry has been growing at an extremely fast rate, even by Brazilian standards. From 1970 to 1975, production increased by 139%. The Brazilian government became enthusiastic with these growth figures and did make a decisive effort to open export markets.

Brazil has been exporting poultry since 1975. In 1975 only 3.4 thousand tons per year were exported but afterwards volumes reached 280 thousand tons per year, equal to some 270 million dollars (Table 25). In this period beef and pork production stayed constant at 2 million tons and 0.5 million tons respectively, but poultry production rose from 413 thousand tons to 1.14 million tons (Table 26).

Simultaneous with the exports, domestic consumption of poultry increased rapidly. This was mainly due to the significant price decrease of poultry meat, as caused by rapid technological change in poultry production. The shift to poultry consumption accounted for the complete increase in meat consumption. Consequently, beef and swine consumption per capita stayed relatively constant (Table 27).

Demand for animal feed rations and maize

Up to the sixties Brazil's industry of animal feed rations was relatively small and mainly directed to dairy cattle (IPEA, 1978). Swine production took place in small holdings, directed to the production of swine fat ("manteca") for baking purposes in the absence of a vegetable oil industry. It was only at the beginning of the sixties, that swine production, on the basis of balanced animal feed rations, started to take place. This was induced by the arrival of new hybrid swine races for meat production. From that moment on the animal feed industry started to grow. Around the same time, the poultry industry got established, showing spectacular growth figures at the beginning of the seventies. The swine and poultry industry created an enormous increase in demand for balanced animal feed (from 2.4 million tons in 1971 to 10 million tons in 1985, Table 28). This caused, in turn, a rapid

Table 24. Animal stock (millions) by region.

Stock	Region				
	South	Southeast	Central West	Northeast	North
Beef					
1973	20.6	32.5	19.5	15.9	2.0
1980	24.6	35.1	33.7	21.9	3.7
1984	24.3	35.0	40.8	21.7	5.9
Swine					
1973	16.4	7.7	3.5	8.9	1.1
1980	15.4	6.1	2.9	8.0	1.9
1984	12.4	5.9	3.5	7.6	3.0
Poultry					
1973	86.7	114.1	16.4	45.7	8.7
1980	152.1	181.7	20.1	72.5	15.0
1984	128.5	105.7	12.7	47.5	12.4

SOURCE: IBGE, Anuario Estatistico do Brasil.

Table 25. Exports of poultry meat 1975-1984, Brazil.

Year	Poultry (millions of t)	Value (US$ in millions)
1975	3.47	3.28
1976	19.64	19.56
1977	32.83	31.57
1978	50.81	46.87
1979	81.10	81.14
1980	168.71	206.69
1981	293.93	354.29
1982	301.79	285.47
1983	289.30	242.21
1984	280.00	270.00

SOURCE: Agroanalysis, FGV, vol 8(10), Oct. 1984.

Table 26. Production (thousands of tons) of meats, 1976-1984, Brazil.

Year	Beef	Swine	Poultry
1976	2176	542	413
1977	2255	462	447
1978	2143	566	587
1979	2114	611	713
1980	2084	699	914
1981	2115	709	1049
1982	2397	626	1192
1983	2365	647	1204
1984	2161	567	1146

SOURCE: Instituto Brasileiro de Geografía e Estatísticas (IBGE). Anuario Estatistico do Brasil.

Table 27. Annual per capita consumption (kg) of meats, 1962-1984.

Year	Beef	Swine	Poultry
1962	17.5	7.8	0.1
1967	17.1	7.7	0.4
1972	19.0	7.9	1.5
1977	20.7	7.4	4.2
1981	23.7	7.9	10.2
1984	22.6	7.4	10.9

SOURCES: IBGE. Anuario Estadistico do Brasil.
Luis Sanint (OP. CIT.).

Table 28. Demand estimations (thousands of tons) for animal feed rations and maize, 1971-1985.

Year	Feed rations			Maize		
	Poultry	Swine	Total	Poultry	Swine	Total
1971	2149	316	2465	1397	7021	8418
1975	4136	821	4957	2688	7375	10063
1982	8828	2512	11340	5738	8558	14296
1985	10816	2671	13487	7030	8670	15700

SOURCES: IPEA. 1978. "Tecnología Moderna para la agricultura", Vol 3.
Luis Sanint. 1985. "Producción de Carnes en el Brazil", unpublished report, CIAT.

modernization of the balanced animal feed and meat production industry, which by now has conversion rates similar to those in the United States.

The strong growth of balanced animal feed consumption created a rapidly increasing demand for maize. Maize is the main animal-feed, raw material in Brazil and normally makes up 65% of the ration. In the last 15 years the consumption of maize by the animal feed industry increased from 8.4 to 15.7 million tons (Table 28).

Until the mid-seventies, Brazil was a maize-exporting country. Afterwards, internal demand increased so rapidly that Brazil had to start importing maize. Between 1977 and 1980 Brazil imported more than 4 million tons. Because of excellent maize harvests in the years between 1982 and 1984 Brazil could again export some maize, but the situation was short-lived. Due to prolonged drought in the central west in 1985 and 1986, the country had to import more than 3.5 million tons in 1986 (Table 28).

The potential application of cassava in animal feed rations; a regional perspective

The large maize imports and the considerable subsidies on the transport of maize from the central west oblige the government to look for alternative animal feed raw material sources. The utilization of dried cassava instead of maize could contribute to the desired maize substitution. This alternative looks particularly viable in the northeast where soil and climate permit low cost cassava production, but almost completely prohibit maize production and reduce the potential of animal feed, poultry, or swine production.

Table 29 shows the geographical distribution of cassava production, maize production and consumption, animal feed production and consumption, and poultry, egg, and swine (estimated) production and consumption. Cassava production is concentrated in the north and northeast, especially on a per capita basis. Maize production is (Table 30) concentrated in the south and central west; two regions that produce a considerable surplus on top of their own consumption needs. In the production of balanced animal feed, again the south and central west produce more than they actually consume. The northeast on the other hand has large deficits of maize as well as animal feed availability.

The ample availability of feed grains in the south and central west has also led to a concentration of poultry, swine, and egg production in these regions (Table 31). Especially in the south, poultry and swine production is very high. In this region per capita poultry and swine production is two and a half times as high as consumption. Surplus poultry production is, to a great extent, exported, while surplus swine production is sold in other regions of the country, mainly the southeast. The relatively high animal production levels in the southeast are based on the cheap transportation of maize and animal feed from the south and central west to this region.

In the northeast, production levels of poultry, eggs, and swine are less than half the levels of the southeast or the central west and less

Table 29. The geographical distribution of cassava production, maize production and consumption, animal feed production and consumption, poultry, egg and swine production and consumption, by region in Brazil, 1983.

Region	Cassava	Maize		Animal feed		Poultry		Eggs		Swine	
	Production	Production	Consumption	Production	Consumption	Production	Consumption	Production	Consumption	Production	Consumption
Total (000 t)											
North	3523.70	279.30	260.00	44.70	73.39	48.89	49.07	22.50	31.52	54.60	45.58
Northeast	10382.72	900.00	1608.00	701.25	900.50	120.00	228.02	123.34	141.03	214.87	321.33
Southeast	2837.46	6080.90	7293.00	4526.73	4666.67	670.00	687.26	491.42	498.32	249.81	540.71
South	4055.01	10343.10	9743.00	5450.07	5106.49	764.00	297.24	228.67	189.73	589.72	243.01
Central west	947.19	2395.10	836.00	355.94	325.17	65.18	67.97	41.76	47.08	97.94	56.32
Per capita (kg)											
North	536.33	42.51	39.57	6.80	11.17	7.44	7.47	3.42	4.80	8.31	6.94
Northeast	276.06	23.93	42.75	18.65	23.94	3.19	6.06	3.28	3.75	5.71	8.54
Southeast	50.13	107.44	128.85	79.98	82.45	11.84	12.14	8.68	8.80	4.41	9.55
South	201.94	515.09	485.21	271.42	254.31	38.05	14.80	11.39	9.45	29.37	12.10
Central west	110.78	280.13	97.78	41.63	38.03	7.62	7.95	4.88	5.51	11.45	6.59

Table 30. Supply, demand, and net imports of maize (thousand of tons), 1977-1986, Brazil.

	Year								
Variable	77/78	78/79	79/80	80/81	81/82	82/83	83/84	84/85	85/86
Supply:									
Initial stock	901.0	1.0	334.2	1180.0	1362.7	1823.4	823.5	2121.0	2441.9
Production	14016.7	16513.2	19484.8	21282.7	21603.7	19014.1	21177.5	21173.9	19870.1
Imports	1500.0	1520.0	2011.0			465.0		200.0	3573.0
Total	16417.7	18034.2	21830.0	22462.7	22966.4	21302.5	22001.0	23494.9	25885.0
Demand	16416.7	17700.0	20600.0	21100.0	20600.0	19740.0	19700.0	21053.0	22154.0
Surplus	1.0	334.2	1230.0	1362.7	2366.4	1562.5	2301.0	2441.9	3731.0
Exports					543.0	739.0	180.0		
Final stock	1.0	334.2	1230.0	1362.7	1823.4	823.5	2121.0	2441.9	3731.0
Net imports	1500.0	1520.0	2011.0	0.0	-543.0	-274.0	-180.0	200.0	3573.0

SOURCE: Companhia de Financiamento da Produção (CFP).

Table 31. Regional surpluses (+) or deficits (-) in maize, animal feed and poultry, egg and swine availability in Brazil.

Region	Maize (000 t)	Animal feed (000 t)	Poultry+egg +swine (000 t)
North	19.30	-28.69	-0.18
Northeast	-708.00	-199.25	-232.17
Southeast	-1212.10	-139.94	-315.06
South	600.10	343.58	852.41
Central west	1559.10	30.77	33.51
Percentage of total consumption			
North	7.42	-39.09	-0.14
Northeast	-44.03	-22.13	-33.63
Southeast	-16.62	-3.00	-18.25
South	6.16	6.73	116.77
Central west	186.50	9.46	19.55

than 20% of the level in the south. To satisfy the demand for these products in the regions, considerable amounts of poultry and swine are brought in. Still, consumption of swine, eggs, and poultry is much lower than it is in the south or southeast. Besides the effect of the lower per capita incomes, reduced consumption levels in the northeast are also caused by the higher prices for swine, poultry, and eggs. During 1981 and 1982 consumer prices of swine, poultry and eggs were, on average, 10% higher in the northeast than in the south.

As shown in Table 29, the northeast runs deficits of 22% to 44% on its maize consumption, its animal feed consumption and its poultry, egg, and swine consumption. Additionally, the low availability of locally produced poultry, swine, and eggs have had their prices increased and their consumption has diminished. In the southeast there is also a deficit on maize, animal feed and eggs, and poultry and swine availability but it is much smaller as a percentage of total consumption.

The previous analysis suggests that dried cassava production in the northeast might be an appropriate way to improve the region's self-sufficiency rates in feed grains, animal feed, and animal products. Additionally, production of dried cassava would widen the market perspectives for the small farmer. Since the traditional market for "farinha da mandioca," has strongly suffered throughout the seventies and early eighties from the wheat subsidies, an alternative cassava market would be very welcome.

Linear programming feed cost models

To find the most efficient composition of balanced animal feed, linear programming models are commonly used. These models try to determine which combination of feedstuffs fulfills the nutritional requirements of animals' diet at the lowest cost. These models have been used in the present study to define at which price level (as a percentage of the maize price) dried cassava would start to substitute for maize (Table 32).

At 74% of the maize price, dried cassava would form 8% of the balanced poultry ration. If the cassava price were to be reduced to 70% of the maize price, dried cassava would enter in the poultry diet with a participation of 10%.

In swine diets, cassava's potential is still much larger. Already at a price of 87% of the maize price, cassava would form 17% of the balanced swine ration. If the dried cassava price were to be reduced to 79% of the maize price, it would form around 30% of the diet.

At the moment the sale price of maize is around 1.69 cruzados per kilogram. This means that at a price of 1.46 cruzados per kg, dried cassava would enter in swine rations and at a price of 1.25 cruzados per kg it would enter in poultry rations.

Table 32. Utilization of dried cassava in animal feed rations based on minimum cost feed models, Brazil.

	Maize[a] (%)	Cassava price/ maize price[b] (%)	Maize (%)	Dried cassava (%)
Hens (layers)	52.35	73.62	44.39	7.99
	52.35	70.41	44.72	9.96
Pigs (60/100 kg)	52.29	86.45	38.80	16.77
	52.29%	78.72%	26.96%	30.48%

a. Cassava utilization artificially restricted to 0 (RHS = 0).

b. Maize price = 1.69 NCr$/kg.

Advantages for the farmer

At present, for the small farmer in the northeast, farinha production forms one of the most important income sources. However, income obtained in this way is highly variable because farinha prices are very unstable. Table 33 shows the instability of farinha prices in a number of urban markets: prices appear to have moved from below 1 to over 5 cruzados per kg.

Most farinha price instability has been caused by supply variations. Since the farinha price-elasticity of demand is between 0 and -1, price fluctuations are always bigger than volume fluctuations. The volume fluctuations, in turn, are caused by the climatic fluctuations, that have a heavy influence on the agricultural sector of the northeast.

Dried cassava as an animal feed would broaden the cassava market to the small farmer, which would have two positive effects on his income. Firstly, the use of cassava as an animal feed would diminish the price fluctuations, to which the farmer is subject in the farinha market. This is illustrated with Figure 1. If only the farinha market exists, random price fluctuations equal to P2-P1 exist. If the cassava market is broadened with the animal feed market, the effective demand for cassava becomes more elastic and price fluctuations will be reduced to P3-P2. This in turn stabilizes the farmer's income.

Secondly, with a new market the income from cassava sales would be increased. Figure 1 shows that before the opening-up of the new market the expected income of the farmer is given by $Y1= E(P)*Q(f)$. When the animal feed market would be opened-up the expected income would be equal to $Y2= E(P)*Q(r)$.

Besides the effect on the income of the farmer, the capacity to generate rural employment in cassava processing would be enhanced. This would be very welcome in the northeast where rural unemployment and urban migration are high. There is no doubt that expansion of cassava production in order to supply the animal feed industry would have a very favorable effect on small-farm income and rural employment.

The Supply of Cassava

Introduction

Cassava is grown in all states of Brazil. The 1985 statistics of the IBGE indicate that 1.87 million ha were planted with a total production of 23 million tons, valued at Cr$1.87 billion. The agricultural census of 1981 estimates that cassava is the eighth most important crop in terms of area planted and the seventh in terms of value (Table 34).

Credit

Despite the fact that cassava has frequently been named as a priority crop by the government, the principal policy instrument to

Table 33. Cassava flour real prices (Cr$/kg) (base year = 1977).

Year	Porto Alegre	Sao Paulo	Rio	Salva-dor	Forta-leza
1969	2.56	3.25	2.13	3.65	1.96
1970	2.72	3.09	2.53	4.46	4.77
1971	3.16	4.39	3.45	6.02	3.83
1972	3.82	4.54	3.47	5.48	3.08
1973	3.43	3.92	3.29	4.30	2.93
1974	3.49	4.49	2.81	3.48	3.60
1975	4.90	5.89	3.31	7.13	4.42
1976	6.75	8.41	6.92	9.11	4.74
1977	5.24	6.33	6.79	2.05	4.11
1978	3.88	4.56	0.72	1.61	3.15
1979	3.73	4.11	0.69	1.86	3.66
1980	5.34	5.12	0.84	1.38	5.15
1981	4.51	4.97	1.14	1.35	5.68
1982	3.13	3.75	3.40	4.31	3.76
1983	2.83	3.13	2.87	2.54	3.17
1984	5.15	5.09	5.14	5.48	5.15

SOURCE: IBGE. Anuario Estatistico do Brazil.

A: The effect on price stability

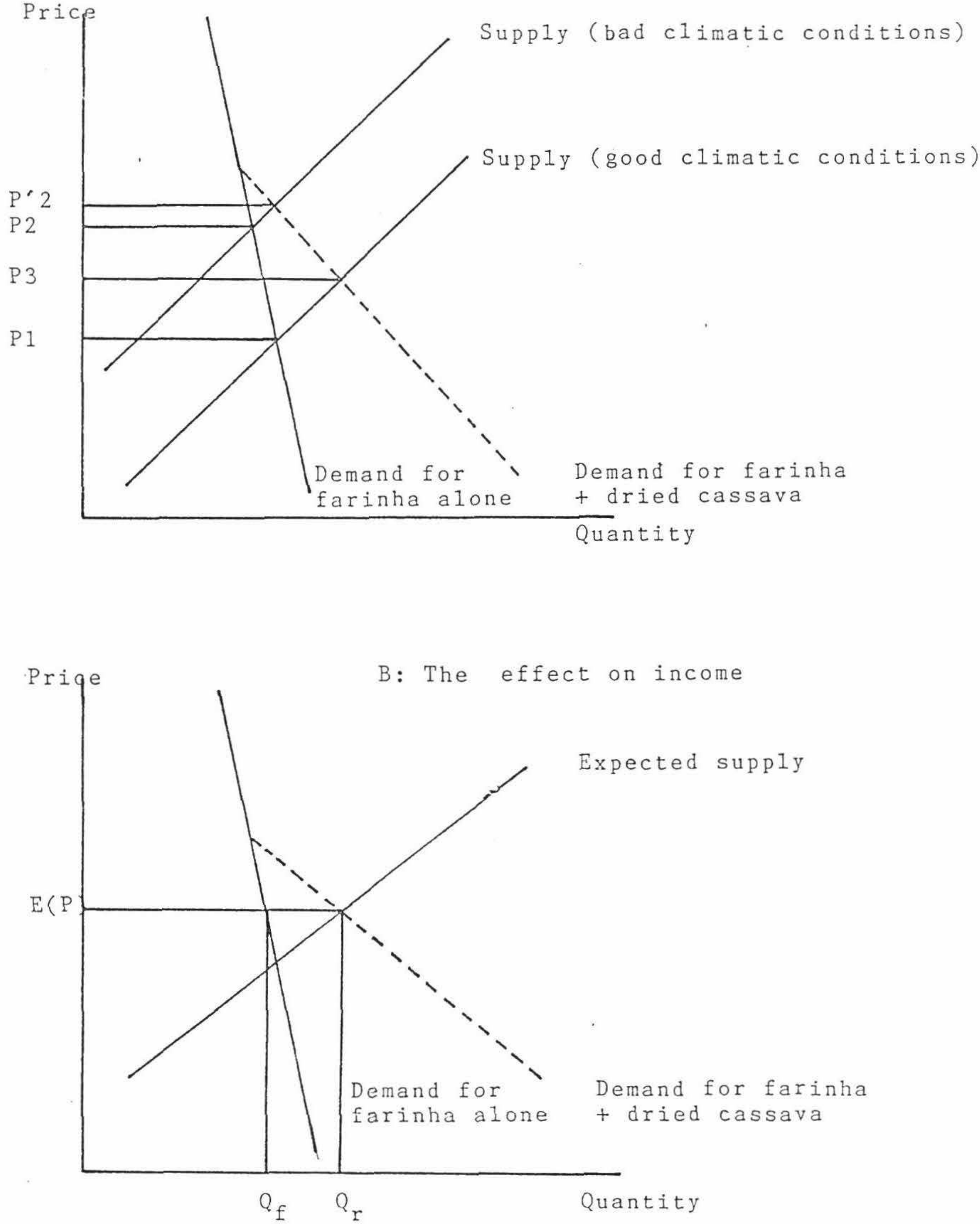

Figure 1. Impact of opening the dried cassava market on prices and incomes

Table 34. Main agricultural products, in order of monetary value including area, production, and yield, in Brazil, 1980.

Product	Area (ha)	Production (ton)	Yield (kg/ha)	Value (thousand Cr$)
Temporary crops				
Soybean	8,774,023	15,155,804	1,727	132,636,930
Sugarcane	2,607,628	148,650,563	57,006	110,737,618
Corn	11,451,297	20,372,072	1,779	119,586,810
Rice	6,243,138	9,775,720	1,565	98,059,130
Beans	4,648,409	1,968,165	423	57,600,228
Cassava	2,015,857	23,465,649	11,640	67,280,181
Cotton	1,353,443	1,439,330	1,063	29,306,153
Wheat	3,122,107	2,701,613	865	29,205,648
Potato	181,084	1,939,537	10,710	22,805,924
Tobacco	316,427	404,660	1,279	12,994,864
Permanent crops				
Coffee	2,433,604	2,122,391	872	88,248,110
Orange[a]	575,249	54,459,072	94,670	32,162,469
Cocoa	482,521	319,141	661	22,897,127

a. Production in thousand fruits, and yield in fruits/ha.

SOURCE: FIBGE.

increase agricultural production, credit, has barely reached the cassava farmer. The production credit for cassava in the last 15 years was only 1.2% of the total (Table 35). As mentioned earlier the government stimulated the export crops; soy received 22% of the total credit. In addition the crops that played a role in import substitution like sugarcane (to produce alcohol in order to replace oil) and wheat received more than 20% of the total. This emphasis obviously reduced the government's ability to respond to the needs of basic food crops such as rice, beans, and cassava which received less than 16% of the total production credit.

On a regional basis the farmer survey showed that in the northeast only 28% of the farmers received credit for cassava production. The figures for the southeast, north, and south are 17%, 10%, and a mere 5% respectively (Table 36).

The principal constraint on obtaining credit, as seen by the farmers, is the excessive bureaucratic requirements of the banks. These include guarantees, land titles, and a multitude of other papers.

Less than 3% of the farmers received marketing credit. Forty percent of the farmers were not aware of the existence of the minimum-price program and 20% of the farmers said that the appropriate agencies would not buy their produce as they had no storage space.

Trends in cassava production

In the last 15 years the total area planted to cassava has remained relatively constant at close to 2 million ha (Table 37). Production has, however, decreased by 6.4 million tons (22%) over the same period. This is due to a shift of production from the central and southern regions to the north and northeast (Table 38).

In order to increase agricultural exports in the decade of the seventies, a strong program was set up to support the production of soy. The result was an expansion in area planted to soy from 1.2 million ha to 9 million ha, mainly in the south of the country. Cassava was displaced towards the northeast. The center and south produced over 50% of the cassava in 1964/66 whilst the northeast produced only 38.5%. By 1983/85 the northeast accounted for 57% of production and the center and south for less than 30% (Table 38).

The climatic and soil conditions of the northeast are much harsher than those of the center and south and, as a result, yields are lower. In the South, 7 out of every 10 years are considered as favorable for cassava production whereas in the northeast only 4 of ten are favorable. Furthermore even in good years the yields in the northeast are lower (Table 39).

Cassava production systems in the different regions

The myth has arisen that cassava is essentially a subsistence crop with almost all the production being used to feed the farmers that produce it. It is indeed an important source of calories for the farmer

Table 35. Participation of cassava (real values, base year=1977) in the production credit (millions of Cr$), in Brasil, 1972-1984.

Year	GPI (%)	Credit: Cassava	Credit: Total	Credit: Percentage (%)
1972	26.25	237	17740	1.34
1973	30.15	195	23841	0.82
1974	38.81	159	33585	0.47
1975	49.63	224	43669	0.51
1976	70.10	342	52306	0.65
1977	100.00	536	90879	0.59
1978	138.74	421	87888	0.48
1979	213.53	1432	91675	1.56
1980	427.47	2057	96490	2.13
1981	897.30	2404	93044	2.58
1982	1753.74	1446	98740	1.46
1983	4463.80	758	71754	1.06
1984	14311.70	803	51509	1.56
Average				1.17

Credit distribution by crop (average 1975/1985)

Crop	%
Soybean	22
Rice	14
Wheat	12
Coffee	11
Sugarcane	9
Maize	8
Cotton	6
Cassava	1
Others	18
Total	100

SOURCE: Anuario Estatístico do Brasil.

Table 36. Use of credit programs (%) for cassava.

	South	Southeast	Northeast	North
Production credit				
Government bank	5%	17%	28%	10%
Private bank	1%	7%	1%	
Without credit	94%	76%	71%	90%
Reasons not to use credit				
High interest rates	25%	14%	11%	26%
Too many procedures	5%	14%	22%	42%
Timing problems	1%	6%	7%	20%
Credit was disapproved			3%	8%
Minimum price program				
Storage option	3%		1%	
Sales option		1%		
No participation	97%	99%	99%	100%
Reasons not to participate				
Minimum price below costs of production	3%	13%	15%	33%
Intervention office did not purchase	17%	15%	27%	26%
Do not know program	40%	46%	42%	37%

SOURCE: Cassava survey. 1986.

Table 37. Trends in cassava production and area harvested.

Year	Area (ha)	Production (t)
1970	2,024,557	29,464,275
1973	2,103,991	26,558,535
1976	2,093,638	25,443,053
1979	2,111,052	24,962,191
1982	2,122,029	24,072,320
1985	1,865,756	23,072,553

SOURCE: IBGE. Anuario Estatístico.

Table 38. Pattern of cassava production (tri-annual averages) in the northeast and center-south.

Period	Northeast (%)	Center-south (%)
1964/66	38.5	56.5
1967/69	42.4	52.7
1970/72	42.6	52.5
1973/75	45.7	48.5
1976/78	51.9	40.0
1979/80	53.9	35.4
1983/85	57.3	28.1

SOURCE: IBGE. Anuario Estatístico.

Table 39. Subjective farmer's appreciation of cassava production and production circumstances.

Question	South	Southeast	Northeast	North
Of every 10 years, how many are				
Good	7	3	4	4
Normal	2	4	3	3
Bad	1	3	3	3
What is your yield in tons per hectare in a				
Good year	30	16	14	18
Normal year	23	11	9	11
Bad year	15	7	6	5
Average yield (t/ha)	27	11	10	12

SOURCE: Cassava Survey. 1986.

and his family, however, the view of cassava as a subsistence crop distorts the reality; cassava plays an important role as a generator of small farm income.

The production systems that are used differ widely depending on the region. There is obviously some variation in production systems within the various regions, however this is less than the variation between regions. In this chapter the most important characteristics of each of the production systems in the different regions are outlined. Nevertheless, one outstanding and uniform feature of cassava throughout the country is that it is essentially a small- or medium-sized farm crop (Table 40).

The north. The north of Brazil is commonly known as the "Rural Frontier." It is characterized by large reserves of virgin forest that form the largest potential area for agricultural expansion in the country. According to the 1980 agricultural census, 70% of the farms are of less than 50 ha with a further 12% between 50 and 100 ha (Table 40). These figures are however suspect. In the survey of cassava farms it was practically impossible to find farms of less than 50 ha.

Due to the great availability of land in the area farmers have increased the size of their holdings and the small farms in the region should be considered as those with 50 to 300 ha. These farms have a very narrow financial base, low availability of labor, and are supported by minimal infrastructure. These smaller farms, dedicated to the production of food and fruits, coexist with very large holdings of 1000 ha or more that produce perennial crops such as rubber, forest crops, and fruits. The lack of a dry period in this area makes it apparently favorable for agricultural production, however the fragile nature of these inherently infertile soils, which rapidly degrade when the forest is cleared, makes sustained agricultural production difficult. In addition the region is prone to periodic flooding. Cassava is the pioneer crop in the region that allows colonizers to get started and then to diversify their relatively large holdings with the inclusion of other crops in their production system; of the farms between 50 and 100 ha cassava planting averages 5.6 ha and occupies 80% of the crop area. It is generally planted as a monocrop or with maize or rice (Table 41). Over 90% of the production is destined to be converted to farinha (Table 42).

Farinha is the basic staple of the region. Grains are difficult to produce and dry in the humid environment and can only be imported to the region at great expense due to the distance from the production sites and also the poor infrastructure in general. The farinha of this area is different from that of the northeast: it is fermented before toasting, has a yellow color, and is known as "farinha d'aqua." This farinha d'aqua is a principle source not only of food but also of cash for the smaller farmers of the region who sell to the small markets developing in the villages which are rapidly appearing in the region.

The northeast. The northeast is characterized by large areas of under-utilized land and disparity in the farm size distribution. Six percent of the farms are greater than 100 ha while 67% of the holdings

Table 40. Distribution of farms by region and size.

Region	Total	Less than 10 ha	Between 10 and 50 ha	Between 50 and 100 ha	Greater than 100 ha
North					
Percentage of farms	100.00%	35.77%	34.58%	12.07%	17.20%
Average size (ha)	102	4	23	71	488
Northeast					
Percentage of farms	100.00%	67.61%	20.72%	5.32%	6.18%
Average size	36	3	23	68	420
Southeast					
Percentage of farms	100.00%	32.57%	39.53%	11.97%	15.71%
Average size	83	5	25	71	399
South					
Percentage of farms	100.00%	39.44%	48.37%	6.12%	5.98%
Average size	42	5	21	68	423

SOURCE: IBGE. 1980. Censo Agropecuario.

Table 41. Cassava farm characteristics.

	South	Southeast	Northeast	North
Area				
Less than 10 ha	35%	25%	78%	
From 10 to 50 ha	57%	41%	16%	
From 51 to 100 ha	6%	14%	3%	49%
Above 100 ha	2%	20%	3%	51%
Area appropriate for cropping (ha)	20.6	12.5	4.5	50.3
Area in:				
Crops	15.2	7.0	3.5	7.0
Pastures	6.5	17.1	2.0	19.2
Area with cassava	2.6	3.8	2.4	5.6
Cassava area as a percentage of:				
Area in crops	17%	54%	69%	80%
Area appropriate for crops	13%	30%	53%	11%
Percentage of cassava in:				
Monoculture	83%	87%	76%	55%
Mixed cropping	17%	13%	24%	45%

Table 42. Destination (%) of harvested cassava by region.

Use	South	Southeast	Northeast	North
Farinha production	3	53	68	91
Starch production	1	36	0	1
Animal feed	80	2	3	6
Fresh cassava sales	16	9	29	2

are less than 3 ha (Table 40). The most fertile soils with the most favorable rainfall distribution are on the coastal strip and further inland there are large cattle ranches interspersed with small farms dedicated mainly to the production of cassava. The region has traditionally been considered as the major farinha-producing area in Brazil.

Cassava is produced mainly by small farmers who plant an average of 2.4 ha. It is their most important crop occupying 69% of the cropped area. From the time when it is less than one-year-old, cassava is harvested continuously with most harvested by the time it is two years old (Table 43). Most of the harvest (69%) is used for farinha production, with smaller amounts (29%) sold either as aipim (fresh cassava) or for farinha production and minimal quantities (3%) are used for animal feed (Table 42).

The continuous harvesting of cassava for the production of farinha provides the farmer and his family with a steady food supply. Furthermore the ability to harvest over time is used by the farmers to obtain a regular cash flow (Table 43). This factor is of particular importance for the smaller farmers of this region who have historically had little access to credit.

The southeast. In an agricultural context, the southeast is a transition area between the northeast and the south. Land distribution is such that the majority (70%) of the land holdings are less than 50 ha with the typical farm being 25 ha (Table 40). Cassava production is concentrated on the areas that border the northeastern states. Climatic conditions are similar to those of the northeast but rainfall patterns are less variable and total rainfall tends to be greater.

The region is highly industrialized and the infrastructure is well developed. Cassava is mainly used for farinha production and to a lesser extent as a source of starch for the industry.

The south. The southern region is characterized by a relatively uniform pattern of land distribution; 88% of the farms are of less than 50 ha with an average size of about 25 ha (Table 40). The soil and climate are favorable for agricultural production and the infrastructure is well developed, especially for the handling of grains and animal products. The agriculture of the region is notable for the preponderance of small- and medium-sized farms, intensive use of the available land for the production of grains and grain legumes, and the production of pigs and dairy products (Tables 41, 42, 44). Cassava fits into the system mainly as livestock feed (Table 45) because of its high productivity per unit area, its low production costs, and its low capital requirements. In general about 80% of the cassava is used as animal feed, however whereas in Rio Grande do Sul this is for dairy, in Santa Catarina it is mainly fed to pigs. The remainder of the cassava is used as food on the farm or sold as aipim (fresh cassava). Farmers consider cassava to be their most important crop in terms of home consumption and for animal feed (Table 43). The average farm which uses cassava as an animal feed consumes 7-12 tons for cattle feed and about 14 tons as pig feed.

Table 43. Age of cassava at harvesting by region.

Age	South	Southeast	Northeast	North
Less than 12 months	36	4	20	38
From 12 to 18 months	39	51	51	49
From 19 to 24 months	20	31	24	11
More than 24 months	5	14	5	2
Reasons to harvest at different age:				
Cash flow	5	27	61	58
Price expectation	38	10	23	10

Table 44. Most important farm products by region in Brazil.

Use	South	Southeast	Northeast	North
Most important product for sale	Soy	Fresh cassava	Fresh cassava	Farinha
	Maize	Starch	Farinha	Rice
	Milk/pigs	Maize	Beans	Maize
Most important product for animal feed	Cassava	Maize	None	None
	Maize	Cassava	Cassava	Cassava
	Pastures	Pastures	Maize	Maize
Most important product for family nutrition	Fresh cassava	Fresh cassava	Farinha	Farinha
	Beans	Farinha	Beans	Rice
	Rice	Rice	Fresh cassava	Maize/bean

Table 45. Cassava as an animal feed in the south of Brazil.

Variable	Cattle			
	Fattening	Dairy	Double Purpose	Pigs
Farms involved in the activity	16%	56%	45%	50%
Number of animals	10	10	17	53
Number of months per year that cassava is used	7	7	8	9
Daily intake/animal (kg/day) of root	3.71	3.51	2.95	1.32
Green matter	.83	3.38	3.57	
Animal feed cassava consumption/farm/year (tons) of root	7.79	7.37	12.04	14.31
Green matter	1.74	7.10	14.57	

In this region the vast majority of the farmers (83%) grow cassava as a monocrop on an average area of 2.6 ha which corresponds to about 17% of their total land area (Table 41). Most of the cassava is harvested between 12 and 18 months and is available to feed livestock throughout most of the year (Table 44).

Private and Social Profitability of Cassava Production in Brazil

Private profitability of cassava production in Brazil

Production costs and production systems differ greatly in Brazil. While in the north of the country all production activities are done manually, in the south cassava production depends heavily on tractor or animal power. In the same way, intercropping with maize and rice is common in the north, while in the rest of the country monoculture is the most common production system. Input use is also very variable. In the north inputs are zero, except for the use of maize and rice seed in the intercrop. In the northeast inputs amount to Cr$438 per hectare--8% of production costs. The major input cost is organic fertilizer, which is applied on average at a rate of 3 t/ha. In the southeast input use is restricted to some insecticides, while in the south organic fertilizer is again a major input. Where used, tractors plus additional machinery make up from 12% to 21% of production costs. In production systems with animal traction, the oxen represent 6% to 13% of production costs. The marked differences in cost structure between cassava production systems can be appreciated in Table 46.

Except for the frontier areas of the north where land is still available almost gratis, land costs represent 20% to 25% of production costs. Land costs are higher in the northeast than in the south, which probably expresses the effect of the very uneven land distribution in the northeast.

Differences in cost structures are not so big as to conceal the dominating importance of labor in every production system. Labor is by far the biggest production cost component, varying from 47% in the south to 87% in the north. In Brazil cassava remains a crop with excellent opportunities to create employment. This is especially true in the north and northeast, where the labor costs correspond with a larger number of labor days than in the south because of lower wages.

The profitability of different production systems is not only determined by production costs, but also by yields obtained and prices received. Yield levels tend to move up from north to south, with the extensively managed systems of the north yielding only 7.4 t/ha and the well managed systems in the south yielding over 20 t/ha. Yield levels tend to depend on the use of machinery, oxen, or labor for land preparation. Manually prepared land yields less than oxen-prepared land, which in turn yields less than mechanically prepared land. On the basis of current data it is difficult to distinguish whether this is because of the method of preparation or because of differences in land quality which require different methods of preparation.

Table 46. Cassava budgets for different management practices and different regions, Brazil, 1986.

Variable	North		Northeast			Southeast	South	
	Monoculture manual	Cassava/maize/rice manual	Monoculture manual	Monoculture tractor	Monoculture oxen	Monoculture manual	Monoculture tractor	Monoculture oxen
Production costs								
Labor	2275	2131.25	3483.75	3153.75	3075	2343.75	2000	2006.25
Inputs		125	438.75	438.75	438.76	29	324.5	324.5
Machinery			700				910	
Animals					330		375	
Land	200	200	1000	1000	1082	800	800	
Interest	148.5	147.375	295.35	317.55	290.6256	207.285	242.07	210.345
Total production costs	2623.5	2603.625	5217.85	5610.05	5134.385	3662.035	4276.57	3716.095
Yield (t/ha)								
Cassava	7.4	3	9.364	13.183	10.733	11.3	34.3	23.3
Rice		0.48						
Maize		0.3						
Price (Cr$/t)								
Cassava	350	350	375	375	375	350	350	
Gross income per hectare	2590	2499	3511.5	4943.625	4024.875	4237.5	12005	8155
Net income per hectare	-33.5	-104.625	-1706.35	-666.425	-1109.51	575.465	7728.43	4438.905
Income attributable to labor and land	2441.5	2226.625	2777.4	3847.325	2965.489	4001.215	10528.43	7245.155
Income per day of labor	26.82967	26.11876	23.91733	33.17302	28.93160	51.21555	363.2107	180.5646
Income per day of labor as % of market wage rate	107.3186	104.4750	79.73443	110.5770	96.43867	170.7185	526.4215	361.1292
Production costs per ton	354.5270	n.a.[a]	557.2244	425.5518	478.3737	324.0738	124.6813	159.4890
Costs per calorie	0.940990	n.a.	1.010155	0.771455	0.867212	0.639709	0.317699	0.406392

a. n.a. = not available.

Price levels are comparable through the country, slightly above the minimum price of Cr$348 per ton, imposed by CFP. However, care has to be taken in the interpretation of these price levels. In southern Brazil only 16% of the harvest is actually sold. When this cassava is sold for fresh consumption ("aipim"), its price is considerably higher, around Cr$2000 per ton. In the north only 2% is actually sold and the rest is used for onfarm production of "farinha da mandioca." Although in the northeast and the southeast larger proportions of the production are sold, more than half of all the cassava produced is transformed or consumed at farm level. In the north, northeast, and southeast cassava profitability is not only a function of yields, prices, and production costs, but also of processing parameters and farinha prices.

The profitability of cassava, given the aforementioned prices, can also be appreciated in Table 46. Four indicators have been developed: net income per hectare, income attributable to land and labor, income per day of labor, and cost of production per ton. The net income per hectare is negative in the north and the northeast and indicates that the value added in cassava cultivation does not allow complete remuneration of the factors of production. In the north the main reason for the negative net income is the low yield levels. In the northeast high production costs cause the negative net income. In the southeast, and more so in the south, the net income per hectare is positive and allows for area expansion or for future wage or land price increases. In fact, in the south the cassava area has been reduced over the last 10 years, but rural wages have already reached a level which is double that of the north and northeast.

The steady existence of cassava in the northeast and the north can be explained by considering the income attributable to labor and land. Even in the north more than Cr$2000 per hectare are available for this purpose. This shows that although land and labor are not remunerated according to going market rates, the farmer does not stay without an income. Underpayment of family resources is a well-known phenomenon in agriculture, partly explained by the problems that farmers and their families face in obtaining employment outside agriculture.

In fact, many farmers who own their land, will consider the cost of land as an integral part of their income. In that case the implicit income per day of labor would be higher than the going day wage in all cases except for the manual and oxen land preparation systems in the northeast. Since it is doubtful whether a farmer would have an equal amount of employment as a day laborer, it becomes clear why cassava production stays a preferable option for many farmers.

The regional differences in the implicit income per day of labor are striking. In the north and northeast the implicit income per day stays around Cr$30, whereas it is Cr$51 in the southeast and Cr$200 in the south. The enormous regional development problem, with large unequalities between south and northeast of Brazil, finds an easy expression in the different implicit incomes.

Costs of production for cassava are considerably lower in the south than in other regions. As a matter of fact, the production costs per calorie of cassava in the south are only about 40% of the production costs per calorie of maize. In the south, onfarm swine feeding, using cassava, has low feed costs and will leave comfortable profits to the cassava/swine producer. However, in a country the size of Brazil, utilization flexibility is not only determined by costs of production, but also by the potential of cassava within the region to substitute for other products. This would open up possibilities for cassava in the northeast, because, although production costs for maize are low in this region, regional maize production only satisfies 55% of local consumption (see p. 44-48).

Reduction of production costs in the north is greatly dependent on improving the ratio of yield levels to labor input. Yield levels may be increased by the introduction of fertilizers, or labor input may be decreased by the introduction of chemical weed control. Production cost reduction in the north has to be achieved simultaneously with improved yield levels and production systems in order to slow down frontier development.

In the northeast there seems to be considerable scope for reducing production costs by introduction of better technology and improved management practices. Management improvements should be directed mainly to the reduction of labor costs. The negative effects on employment that this would have, could be easily offset by the increased effective demand that cheaper cassava would face. Decreased production costs could be of great significance, allowing cassava to act as a maize substitute in order to reduce the maize deficit of the northeast while simultaneously improving profitability to the producer.

In the southeast, production costs are at present lowest in the production system involving manual land preparation. The future feasibility of this system in the region is limited, given the strong incentives for rural laborers to migrate toward industrial centers where wages are considerably higher. Cassava production will therefore have to take place in more mechanized systems, based on oxen or tractor power. The main reason for the relative high costs of production in this region are the low yield levels. Contrary to the northeast as well as the south, farmers in the southeast do not use organic fertilizer. Introduction of better soil fertility practices could be instrumental in increasing yields and reducing production costs.

In the south production costs are already very low. Production is intensively managed, input levels are high, yield levels are outstanding. Further cost reduction would probably be realized by improving mechanization practices and by introducing new varieties.

The profitability of "farinha da mandioca" and "polvilho" processing

"Farinha da mandioca" production is important in the north, northeast, and southeast of Brazil. Farinha is mainly processed in small-scale processing facilities, often at the farm. "Polvilho" or starch is an important product in the southeast where it is processed in plants with very varying sizes.

A rough calculation of variable "farinha da mandioca" processing costs is made in Table 47. On the assumption that 10 tons of cassava are needed to produce 3 tons of farinha, the raw material costs are equal to Cr$1250 per ton. Raw material accounts for 68% of variable farinha production costs and forms by far the biggest cost component. The second biggest cost component is labor, needed for peeling, chipping, and other processing activities. This sums up to Cr$420 or 23% of variable farinha production costs. Inputs (petrol, firewood, packings) total Cr$160 per ton, 9% of variable costs.

The calculation of starch-processing costs can be found in Table 46 as well. Raw material costs are considerably higher than in the case of farinha, because the conversion of cassava to starch is less efficient than the conversion to farinha. Labor costs in starch production are also considerably higher. This involves peeling, as well rasping, straining, and drying. Also fuel costs, to dry the starch, are high. However, since the price of starch is considerably higher than the price of farinha, starch production remains a profitable activity.

Variable costs for farinha production are already higher than farinha prices, which implies that the remuneration to production factors has to be below going market rates. If fixed costs, which mainly consist of depreciation and interest on investments, are assumed to be zero, than labor can still be paid only at 76% of the market rate of the northeast and southeast. Labor in farinha production is to a great extent supplied by the women and children of the farm family. Their ability to find productive and better paid employment outside the farm is often minimal, and forces them to supply their labor below the market rate.

In the southeast, cassava is in fact produced at Cr$60 below the assumed costs of Cr$375 per ton. In this case, the profitability of producing cassava compensates for the losses in farinha processing. Although cassava production looks a profitable activity and cassava processing an unprofitable activity, the integrated activity of production and processing breaks more or less even in this region. Additionally, a profit can be made in starch processing.

In the northeast the situation is less rosy. The net profitability of cassava production was shown to be negative, to the extent that farmer-owners, who do not reckon land costs, are still perceiving a daily income which is below the market wage rate. In this case, the integrated activity of cassava production and processing maintains itself only because the income alternatives for the farmer and his family outside agriculture are reduced. Given the dominance of raw material costs in the total costs for farinha processing, the profitability of cassava production and processing will be most rapidly improved by decreasing production costs.

The Domestic Resource Costs of Cassava Production in Brazil

In Brazil, as in most other countries, internal prices are not freely formed in the confrontation of demand and supply, but are partly

Table 47. Variable processing costs (in Cr$) of farinha and starch, Brazil.

Costs	Farinha production	Starch production
Raw material	1250	2250
Peeling	150	270
Chipping	100	180
Other salaries	170	420
Petrol	10	180
Firewood	70	0
Packing	80	140
Total costs	1830	3440
Farinha price/ton	1730	3660
Losses per ton of farinha cassava/ton	-100	220
Labour payment/ day wage	0.76	1.25

determined by existing subsidy and tax structures, as well as by existing market rigidities. Regarding costs, price deviations represent transfers of income by the rest of the economy to (in case of subsidies) or from (in case of taxes) producers. Considering output prices, subsidies imply a transfer to and taxes imply a transfer from producers. These price deviations imply that the private profitability of an activity is not necessarily equal to the profitability of the activity for the country as a whole. This complicates the understanding of which activities are most economically performed in the country, as regards to questions of domestic production versus imports, or the production of certain commodities versus their substitutes.

Therefore, apart from the private costs of cassava, it is useful to understand the social costs of cassava production, that is, after correction for subsidies, taxes, and market rigidities. This parameter, as calculated in domestic resource costs (DRC) analysis, indicates to what extent internal production of cassava is preferable to the importation of cassava or its substitutes, or to what extent cassava production uses more or fewer resources than the production of its substitutes.

International cassava trade to and from Brazil is almost zero, with the slight exception of some dried cassava that was incidentally exported to Western Europe in the seventies. This means that the comparison of domestic cassava production with cassava imports is not relevant. However, within the country, cassava flour is a partial substitute for wheat flour, while dried cassava is a substitute for feed grains such as maize and sorghum.

Production prospectives of cassava flour versus wheat flour

As regards to the possible substitution of cassava flour for wheat flour, it is difficult to make a correct DRC-analysis due to the absence of reliable wheat production costs data. It is also hard to estimate, to what degree the two products can actually substitute each other. Nevertheless, some brief remarks on the substitution between wheat and cassava flour can be made. Since the beginning of the seventies, the wheat price was heavily subsidized in order to stimulate wheat production and to decrease the cost of the diet of the urban poor. Seventy-one percent of the acquisition costs of wheat by the wheat mill are covered by a government subsidy, which results in a 65% subsidy of the price of wheat flour or a 38% subsidy of the price of bread. As a result of the wheat subsidy, cassava flour, which was 35% cheaper in 1970, became three times as expensive in 1980 (Table 48). Without the subsidy cassava flour and wheat flour would have been in the same price range. Although the 1980 wheat-flour/cassava-flour price ratio still implies certain progress of wheat-flour productivity versus cassava-flour productivity, cassava-flour consumption would probably not have dropped so quickly as it appears to have done. The firmly established wheat subsidy policy has increased wheat production and has decreased the cost of the diet of the urban poor, but has done this at the cost of the income of the cassava farmer and processor.

Table 48. Relationship between farinha da mandioca and wheat consumption, and their respective prices, Brazil.

	1960	1970	1980
Farinha consumption (kg per capita)	26.3	23.5	12.0
Wheat consumption (kg per capita)	26.2	25.2	45.5
Farinha: wheat consumption	1.00	0.93	0.26
Farinha: wheat prices	0.61	0.64	2.95

Production prospectives of dried cassava as an animal feed

Although production costs for cassava and maize in Brazil are affected by a number of subsidies and taxes, the potential for dried cassava to substitute maize and sorghum as animal feed raw material is not constrained by government interventions similar to those in the case of wheat. As mentioned before (p. 71), the potential of cassava to substitute for maize looks best in the northeast.

In 1986 maize was supplied in the northeast from four areas. The first area of supply was the northeast itself. Data of CFP (Companhia de Financiamento da Producao) for 1985, that were corrected for inflation, suggest production costs for local maize of around Cr$1517 per ton (Tables 49 to 59). The second area that supplied maize to the northeast is the south. Maize is shipped by sea from Paraná to Pernambuco or Ceará and is mainly consumed in coastal areas. The costs of supplying this maize to the northeast are around Cr$1616 per ton, 45% of which are transport costs. The third area which supplies the northeast is central west, mainly the department of Goias. Maize from this area is transported by truck to those areas of the northeast that cannot easily be reached from the ports. In 1986 this maize could be supplied at a cost of Cr$2494 per ton. Transport absorbs 50% of the costs of supplying this maize, due to the long distances, the bad roads, and the absence of return freight. Also maize was imported at a cost of approximately Cr$1705 per ton. Maize from the region as well as from the south would compete with CIF maize import prices, but maize from Goias would only find its way into the market through the minimum price schemes operated by CFP (this means buying at a price of Cr$1480 per ton in Goias, transporting to a deficit region and selling at the going market rate, while absorbing the transport costs).

In the costs for supplying maize from the northeast the cost of capital is very high (Tables 50 to 55). This is due to the fact that these cost data were gathered when inflation and, therefore, interest rates were still galloping. If these production cost data had been gathered after the establishment of the Plan Cruzado-I, other cost factors would have been higher while capital costs would have been lower. Because of the low yield levels (estimated at 1350 kg/ha) land costs were also high.

Inputs form a considerable part of the cost of supplying maize for all the three systems studied. For maize from the northeast, inputs constitute almost 30% of total supply cost; for maize from the south and central west, it takes, respectively, 40% and 60% of total supply cost. Fuel for transport or traction is a very important input and, since Brazil is a net importer of energy, it involves a relative high cost to the country in terms of foreign exchange.

As part of the Plan Cruzado-I, which tried to control the galloping inflation, maize prices were frozen in 1986 at a price level of Cr$1483 per ton. The difference between the frozen price and the actual costs of supplying maize was absorbed from the government's budget. This does not appear to be a long-term policy and therefore has not been taken into account in the present analysis.

Table 49. Private and social costs of supplying maize or dried cassava in the northeast of Brazil, 1986.

	Private costs	Social costs
Locally produced maize	1516.6	1404.8
Maize from the south	1615.9	1467.5
Maize from central west	2493.9	2130.1
Imported maize	1705.0	1675.0
Locally produced dried cassava	1455.1	1379.4
Locally produced dried cassava, factors paid at opportunity costs	1306.4	1230.7

Table 50. Northeast local maize production and supply costs, per ton, nominal prices,[a] 1986, Brazil.

	Factor costs			Input costs		Total
	Labor	Land	Capital	Tradeables	Nontradeables	
Farm level						
Fixed costs	18.5	444.4	101.4	18.0	3.2	585.4
Variable costs	275.9		133.5	313.6	9.3	732.2
Total costs	294.3	444.4	234.8	331.6	12.5	1317.7
Price	Cr$3.25/ha	Cr$600/ha	n.a.[b]			
Transportation						
Fixed costs	44.1		25.9	33.4		103.4
Variable costs	12.1			83.4		95.5
Total costs	56.3		25.9	116.7		198.9
Total						
Fixed costs	62.6	444.4	127.3	51.4	3.2	688.9
Variable costs	288.0		133.5	396.9	9.3	827.7
Total costs	350.6	444.4	260.7	448.3	12.5	1516.6

a. Cr$14.2 = US$1.00.

b. n.a. = not available.

Table 51. Northeast local maize production and supply costs,[a] per ton, shadow prices, 1986, Brazil.

	Factor costs			Input costs		Total
	Labor	Land	Capital	Tradeables	Nontradeables	
Farm level						
Fixed costs	18.5	444.4	98.9	14.4	3.2	579.4
Variable costs	275.9		120.1	256.9	9.3	662.2
Total costs	294.3	444.4	219.0	271.3	12.5	1241.6
Price	Cr$3.25/ha	Cr$600/ha	n.a.[b]			
Transportation						
Fixed costs	44.1		20.7	26.7		91.6
Variable costs	12.1			59.5		71.6
Total costs	56.3		20.7	86.2		163.2
Total						
Fixed costs	62.6	444.4	119.6	41.1	3.2	671.0
Variable costs	288.0		120.1	316.4	9.3	733.8
Total costs	350.6	444.4	239.7	357.5	12.5	1404.8

a. Cr$14.2 = US$1.00.

b. n.a. = not available.

Table 52. Northeast maize supply costs[a] from the south per ton, nominal prices, 1986, Brazil.

	Factor costs			Input costs		Total
	Labor	Land	Capital	Tradeables	Nontradeables	
Farm level						
Fixed costs	27.5	220.0	27.5	56.6		331.6
Variable costs	330.0		32.2	193.2		555.4
Total costs	357.5	220.0	59.7	249.7		887.0
Price	Cr$6.25/ha	Cr$800/ha	n.a.[b]			
Transportation						
Fixed costs	107.5		133.7	163.4		404.6
Variable costs	95.8			228.5		324.3
Total costs	203.2		133.7	392.0		728.9
Total						
Fixed costs	135.0	220.0	161.2	220.0		736.2
Variable costs	425.8		32.2	421.7		879.7
Total costs	560.8	220.0	193.5	641.7		1615.9

a. Cr$14.2 = US$1.00.

b. n.a. = not available.

Table 53. Northeast maize supply costs[a] from the south per ton, shadow prices, 1986, Brazil.

	Factor costs			Input costs		Total
	Labor	Land	Capital	Tradeables	Nontradeables	
Farm level						
Fixed costs	27.5	220.0	26.7	45.2		319.4
Variable costs	330.0		31.3	175.0		536.3
Total costs	357.5	220.0	57.9	220.3		855.8
Price	Cr$6.25/ha	Cr$800/ha	n.a.[b]			
Transportation						
Fixed costs	107.5		106.7	130.8		344.9
Variable costs	95.8			171.0		266.8
Total costs	203.2		106.7	301.8		611.7
Total						
Fixed costs	135.0	220.0	133.3	176.0		664.3
Variable costs	425.8		31.3	346.1		803.1
Total costs	560.8	220.0	164.6	522.1		1467.5

a. Cr$14.2 = US$1.00.

b. n.a. = not available.

ble 54. Northeast maize supply costs[a] per ton, nominal prices, 1986, Goias, Brazil.

	Factor costs			Input cost		
sts	Labor	Land	Capital	Tradeables	Nontradeables	Total
rm level						
ixed costs	37.0	200.6	48.6	100.2		386.4
ariable costs	150.2		40.2	663.1		853.5
otal costs	187.3	200.6	88.8	763.3		1239.9
rice	n.a.[b]	Cr$461/ha	n.a.			
ansportation						
ixed costs	173.5		156.9	192.8		523.2
ariable costs	148.0			582.8		730.8
otal costs	321.5		156.9	775.6		1254.0
tal						
ixed costs	210.5	200.6	205.5	293.0		909.5
ariable costs	298.3		40.2	1245.9		1584.3
otal costs	508.8	200.6	245.7	1538.8		2493.9

Cr$14.20 = US$1.00.

n.a. = not available.

able 55. Northeast maize supply costs[a] per ton, shadow prices, 1986, Goias, Brazil.

osts	Factor costs			Input costs		Total
	Labor	Land	Capital	Tradeables	Nontradeables	
arm level						
Fixed costs	37.0	200.6	38.9	80.1		356.6
Variable costs	150.2		35.2	564.1		749.5
Total costs	187.3	200.6	74.0	644.2		1106.1
Price	Cr$6.25/ha	Cr$800/ha	n.a.			
ransportation						
Fixed costs	173.5		130.3	154.2		458.0
Variable costs	148.0			417.0		566.0
Total costs	321.5		130.3	572.2		1024.0
otal						
Fixed costs	210.5	200.6	169.2	234.4		814.6
Variable costs	298.3		35.2	982.0		1315.5
Total costs	508.8	200.6	204.4	1216.4		2130.1

. Cr$14.20 = US$1.00.

. n.a. = not available.

Table 56. Northeast dried cassava production, processing and marketing costs,[a] per ton, nominal prices, 1986, Brazil.

	Factor costs			Input costs		Total
	Labor	Land	Capital	Tradeables	Nontradeables	
Farm level						
Fixed costs	86.4	189.6	26.5	79.6		382.2
Variable costs	538.3		63.1	7.0	76.2	684.5
Total costs	624.6	189.6	89.6	86.6	76.2	1066.7
Price	Cr$3.25/ha	Cr$1000/ha	6%			
Processing						
Fixed costs	35.3	0.9	11.4	48.8		96.4
Variable costs	70.3		6.2	15.5		92.0
Total costs	105.6		17.6	64.3		188.4
Transportation						
Fixed costs	44.0		26.0	34.0		104.0
Variable costs	12.0			84.0		96.0
Total costs	56.0		26.0	118.0		200.0
Total						
Fixed costs	165.6	190.5	63.9	162.5		582.6
Variable costs	620.6		69.3	106.5	76.2	872.5
Total costs	786.2	190.5	133.2	269.0	76.2	1455.1

a. Cr$14.20= US$1.00.

Table 57. Northeast dried cassava production, processing and marketing costs,[a] per ton, shadow prices, 1986, Brazil.

	Factor costs			Input costs		Total
	Labor	Land	Capital	Tradeables	Nontradeables	
Farm level						
Fixed costs	86.4	189.6	21.2	59.7		357.0
Variable costs	538.3		63.1	5.6	72.4	679.3
Total costs	624.6	189.6	83.0	65.3	72.4	1036.3
Price	Cr$3.25/ha	Cr$1000/ha	6%			
Processing						
Fixed costs	35.3	0.9	10.7	46.2		93.0
Variable costs	70.3		6.2	10.9		87.4
Total costs	105.6		16.9	57.0		180.3
Transportation						
Fixed costs	44.0		20.8	27.2		92.0
Variable costs	12.0			58.8		70.8
Total costs	56.0		20.8	86.0		162.8
Total						
Fixed costs	165.6	190.5	52.7	133.1		542.0
Variable costs	620.6		69.3	75.2	72.4	837.5
Total costs	786.2	190.5	122.0	208.3	72.4	1379.4

a. Cr$14.20 = US$1.00.

ıble 58. Northeast dried cassava production, processing and marketing costs[a], per ton, nominal prices, opportunity costs for labor and land, 1986, Brazil.

	Factor costs			Input costs		
	Labor	Land	Capital	Tradeables	Nontradeables	Total
ırm level						
'ixed costs	95.5		26.5	79.6		201.7
'ariable costs	595.2		63.1	7.0	76.2	741.5
:otal costs	690.7	0.0	89.6	89.6	76.2	943.1
'rice	Cr$3.60/ha	Cr$0.0/ha	6%			
:ocessing						
'ixed costs	26.9	0.9	11.4	48.8		88.0
'ariable costs	53.6		6.2	15.5		75.3
:otal costs	80.5		17.6	64.3		163.2
:ansportation						
'ixed costs	44.0		26.0	34.0		104.0
'ariable costs	12.0			84.0		96.0
:otal costs	56.0		26.0	118.0		200.0
ɔtal						
'ixed costs	166.4	0.9	63.9	162.5		393.7
'ariable costs	660.8		69.3	106.5	76.2	912.7
:otal costs	827.1	0.9	133.2	269.0	76.2	1306.4

. Cr$14.20 = US$1.00.

ble 59. Northeast dried cassava production, processing and marketing costs, per ton, shadow prices, opportunity costs for labor and land, 1986, Brazil.

	Factor costs			Input costs		
	Labor	Land	Capital	Tradeables	Nontradeables	Total
rm level						
'ixed costs	95.5		21.2	59.7		176.5
'ariable costs	595.2		63.1	5.6	72.4	736.3
'otal costs	690.7	0.0	89.0	65.3	72.4	912.7
rice	Cr$3.60/ha	Cr$0.0/ha	6%			
ocessing						
'ixed costs	26.9	0.9	10.7	46.2		84.6
'ariable costs	53.6		6.2	10.9		70.6
otal costs	80.5		16.9	57.0		155.2
ansportation						
'ixed costs	44.0		20.8	27.2		92.0
ariable costs	12.0			58.8		70.8
'otal costs	56.0		20.8	86.0		162.8
tal						
'ixed costs	166.4	0.9	52.7	133.1		353.1
'ariable costs	660.8		69.3	75.2	72.4	877.7
otal costs	827.1	0.9	122.0	208.3	72.4	1230.7

Cr$14.20 = US$1.00.

Although maize production is not subsidized in a similar way to wheat, the private costs of supplying maize do not form a true reflection of the social costs, because a number of taxes on inputs increase maize production and marketing costs. For example, although Brazil produces most of its tractors itself, this production takes place behind a tariff wall of 30% on the CIF-value of every imported tractor. Similarly, there is a duty of 50% added value on most agrochemicals. Internal taxes on nontradeable inputs could have disrupted further the picture of social versus private costs, but happened to be zero for all inputs considered. This means that costs have to be corrected mainly for the import duties on tradeable cost items in order to obtain an unbiased judgment on the social costs of maize production.

Correcting these costs is complicated in the case of Brazil for a number of reasons. Brazil maintains some 28 different import regimes and it is difficult to discover which import regime has been effective for a certain product. In the case of production behind a tariff wall, as in the case of tractors, the nominal duty might be higher than the real duty needed to protect the industry. Additionally, although it may appear that the internal production of a certain commodity is inefficient in comparison with external production, the abolition of internal production may raise the request for foreign exchange to so high a level that internal production would appear efficient (a paradox similar to the one that can be found in defining a Pareto-optimum). Given these complications, the probable social costs of supplying maize to the northeast are outlined in Table 49.

Maize can be supplied to the northeast at a social cost of Cr$1405 when coming from the region, at a cost of Cr$1467 when coming from the south, at a cost of Cr$2130 when coming from Goias, or at a cost of Cr$1675 when imported (Table 49). Within the social costs of maize supply, inputs play a less dominating role, but can still absorb more than 50% of total costs.

Dried cassava can be supplied to the northeast at an approximate private cost of Cr$1455 per ton (Table 49). Comparable shares of some 14% are needed to process fresh into dried cassava and to transport dried cassava to the consumer. The rest, over 70%, are production costs (Tables 56 to 59). The cost structure of cassava supply demonstrates that more than 50% of the total costs are labor costs, while only 20% are input costs. Cassava is basically supplied by production factors and needs at considerably lower input levels than maize.

After correcting the private costs for subsidies and taxes a social cost of cassava supply of Cr$1379 per ton results (Table 49). The costs of supplying dried cassava in that case vary between 98% of the cost of local maize to 65% of the cost of maize from Goias. Since Brazil might well be importing maize in the coming years, the cost of supplying dried cassava versus the cost of supplying imported maize is especially relevant. This value is around 83%.

It should be taken into account that, at the moment, the farmer in the northeast does not receive complete remuneration for his production factors. In the most profitable system the net income per hectare still stays at Cr$666 negative. At the same time, processing labor receives only 76% of the market wage. If cassava supply costs are calculated, not on the basis of market prices, but on the basis of the present remuneration of production factors, the supply costs as presented in the bottom of Table 49 result. In this case, dried cassava could be supplied at Cr$1306 per ton, if calculating at private costs, or at Cr$1231 per ton, if calculating at social costs. At private costs the cost of supplying dried cassava vary between 86% and 52% of the cost of supplying maize, at social costs they vary between 88% and 58%.

The competitiveness of dried cassava versus maize as a balanced animal feed raw material is summarized in Table 60. Linear programming models have already shown that dried cassava would be an efficient substitute for maize in layer hen rations at 74% of the maize price. That would make dried cassava competitive in comparison with maize from Goias or with imported maize, but in the last case only if calculated with shadow prices and opportunity costs of labor and land. Although dried cassava forms an attractive option from the national point of view, some government support (for example, credit subsidies on processing equipment or transport cost reduction) would be necessary to make it a viable option for the private enterprise. Dried cassava enters as a maize substitute in pig rations at 86% of the maize price. It would therefore be competitive with imported maize or brought in from Goias and, if calculated with opportunity costs for land and labor, with maize supplied from the south.

Regarding the competitiveness of dried cassava versus imported maize, it is important to consider the effect of the exchange rate. For every 10% that the exchange rate goes down, the price ratio of dried cassava versus imported maize would decrease with some 6%. The exchange rate of Cr$14.2 to the U.S. dollar, used in this study, was the official exchange rate in October 1986. However in the black market, the exchange was almost double. therefore, it is not unrealistic to state that Brazil's exchange rate at the moment of analysis, was overvalued by at least 20%. In that case, dried cassava would be fully competitive with imported maize as an energy source for layer-hen rations, or any other balanced animal feed, especially if production factors are paid at full market rate instead of their presently low opportunity costs.

It should be noted that cassava already plays an important role as fresh animal feed in southern Brazil. It has potential to play an important role in the dried form in northeast Brazil. There is also obvious potential for cassava to form part of swine rations, and there also appears to be potential to form part of layer-hen rations. Improved production technology that would decrease the cost of dried cassava would enhance this potential. Additionally, increased feed availability can be expected to stimulate further growth of the animal feed and animal production sector, partly creating its own demand.

In former days, when Brazil was a residual exporter of maize, dried cassava production in the northeast replaced maize from Goias, which was exported at a considerable loss. Production of dried cassava in the northeast therefore invoked a regional development conflict between the northeast and the central west. At the moment, Brazil is not

Table 60. Costs of supplying dried cassava[a] as a percentage of the cost of supplying maize, northeast region of Brazil, 1986.

Maize supply region	Remuneration of factors in cassava production			
	At market wage		At opportunity costs	
	Costs		Costs	
	Private	Social	Private	Social
Local	96	98	86	88
South	90	94	81	84
Central west	58	65	52	58
Imported	85	83	77	73

a. Maximum price ratios at which dried cassava forms part of balance feed: Laying hens: 0.737 (7% participation); Pigs: 0.865 (16% participation).

self-sufficient in maize production, and any increase in local production of maize or its substitutes would be welcome. Dried cassava would not only contribute to the rural development of the northeast, but would also allow Brazil to divert its scarce foreign exchange from maize to other products.

Conclusions: The Need for Cassava Development in Brazil

Cassava is an important crop in Brazil. It holds eighth place as regards to area planted, and seventh place regarding monetary value. After rice and sugar, it shares third place with wheat, beans, oils, and fats in providing calories for the Brazilian diet. Cassava is an especially important crop in Brazil because it is grown mostly by small farmers and consumed mostly by poor urban or rural consumers. Therefore the crop can play a dominating role in equity oriented programs that aim to mitigate the effects of the skewed income distribution of the country.

The importance of cassava stems not only from its monetary value, but also, possibly to an even larger extent, from the specific functions it has performed and will perform within the Brazilian economy. One of these functions is the provision of a gradual, well-spread cash flow to severely financially constrained farmers. This steady cash flow allows these farmers to purchase daily life essentials through most of the year without having to borrow at often excessive rates.

Another function of cassava has been its availability in times of drought and famine. During the drought period from 1978 to 1983 in the northeast of the country, cassava was, for many people, the first and often only relief from starvation. For the government it was one of the buffers against social unrest.

A third important function stems from its ability to grow in marginal agroecological conditions. In many parts of the northeast it forms the only viable crop for the peasant population, and in northern Brazil it allows the colonizers a readily accessible calorie source to survive the first tough years of opening up the land.

Finally, because of its high-yield potential per hectare, it forms an extremely cheap calorie source for onfarm animal feeding, particularly in southern Brazil. Here the availability of high-yielding cassava has allowed small and intermediate farmers to intensify their agricultural operations, venturing into export crops such as soybean, and pig production.

Brazil is the most important cassava producer of the world, but this position is apparently at risk because of the reduction in production that has taken place in the last 15 years. Between 1970 and 1985 production went down from 29 to 23 million tons, which means that per capita production was almost halved.

The urbanization process, which always tends to negatively affect rurally produced traditional staples, has been a first cause for the decreasing importance of cassava. In the rural areas of Brazil consumption levels of fresh cassava as well as farinha are about three times as high as in the urban areas.

Another reason for the decreasing importance of cassava can be found in the agricultural policies of Brazil. Most agricultural policies of Brazil have been directed toward export promotion (soybean, cotton) and, in a later phase, import substitution (sugarcane and, to a certain extent, wheat). The most important policy instruments have been the provision of subsidized credit as well as the development of a minimum price support program. The direct budgetary costs of these programs have not been excessive, certainly not compared to spending in USA or EEC agriculture, except for the case of wheat, where a price subsidy of over a billion U.S. dollars takes place. However, the emphasis on export crops came at the expense of domestic food crops. As a result, growth in food supply in Brazil has been inadequate and the nutritional condition of the Brazilian population is poor.

Low-input crops such as cassava are naturally disadvantaged by credit subsidies, but additionally the amounts of credit available for cassava were very much smaller than those for example, soybean, cotton, or maize. On top of that, most cassava farmers have problems fulfilling the official requests for credit. At the same time, it appears that the minimum price programs for cassava (flour) have not been functioning well. These factors have led to large-scale substitution of cassava by soybean, especially on the fertile land of the south.

Moreover, the regional development policies pursued by the Brazilian government did not favor cassava. Since the sixties and the foundation of Brasilia most efforts have been directed towards opening up the agricultural frontier in central west Brazil. The south and southeast, which had relatively high development levels anyway, could autonomously finance infrastructure expansion. They also benefited from the spinoff from the development of the central west and by the export-oriented agricultural policy, directed to crops grown in the south. The northeast, where cassava production was concentrated, not only was neglected but was adversely affected by regional policies in the rest of Brazil.

The knockout blow for cassava in Brazil has been the wheat subsidy. Between 1970 and 1980 wheat prices decreased from about equal to only one-third of the farinha prices. Consequently, wheat consumption doubled, at a high cost to farinha consumption.

Just as the present status of cassava has been defined by agricultural policy, its future role will also be determined by policies. The question, therefore, is to what extent the existing policies can be expected to stay the same or to change in favor of or against cassava production and utilization.

In 1985 Brazil returned to a democratic government, after two decades of military rule. The new democratic government is more inclined to direct policies to those fields where the benefits for the electorate are largest. Among other objectives, adequate nutrition of the population and control of the previously galloping inflation will be stressed. For both reasons it is not expected that the wheat subsidy will be eliminated, but it may well be that other food products will receive more attention.

At the same time the democratic government is looking for development opportunities in the northeast where more than 35 million people are living. In collaboration with the World Bank, a special program for the northeast (SUDENE) has been established. Within this program cassava development could help to improve income prospects of the rural poor.

A third consideration for the Brazilian government is the continued scarcity of foreign exchange, mainly due to the large interest and debt service payments. Consequently, the government is interested in autonomous development of its industrial sector and in maximum levels of agricultural self-sufficiency. The growth of the Brazilian animal-feed industry up to the present has been mainly supported by domestic maize production, incidentally supplemented with imported maize. In this respect, it has responded satisfactorily to the government desire to save foreign exchange. However, it appears infeasible that maize supply will grow quickly enough to maintain the historic growth rate of the animal feed industry. Instead of importing maize, the government could decide to promote the use of dried cassava in animal feed rations. Apart from the positive effect on foreign exchange availability, this could shift the regional balance of animal feed production (and probably swine and poultry production and consumption) towards the northeast.

The recent changes in the Brazilian political environment will have lasting effects on the government's policies. Issues that were neglected until recently will receive more attention. The government will emphasize the development of the northeast, will try to control inflation, will try to improve the nutritional status of the poor urban dweller, and will attempt to redress its balance of payment. It can be concluded that the future for cassava in such an environment is more promising than in the past. In the same way, it can also be concluded that cassava's potential to contribute to government policies is larger than in the past. However, to realize cassava's contribution towards development it is necessary to focus on the most appropriate ways of utilization.

At present, cassava is mainly utilized in four different forms in Brazil. The most important form is farinha. Farinha consumption has been declining over the last 15 years, basically because its relative price has become less competitive. It remains and will remain, however, a very important product for the Brazilian consumer, especially for the very poor. Given the increasing numbers of poor people in the Brazilian cities (the urban income distribution has become notably worse) it can even be shown that farinha demand at constant prices has increased over the last ten years.

To improve the role of farinha as a staple food an integrated strategy is necessary. Increased per capita consumption will basically depend on better availability, better quality, and lower prices. Therefore, efforts should be undertaken to decrease the costs of cassava production and to streamline farinha processing and distribution. The distributive impact of cheaper farinha is considerable. Pachico (1981) calculated that 46% of potential benefits would accrue to the poorest 25% of the population. Williamson-Gray (1982) calculated that of each dollar of subsidy spent on farinha 60 cents would be transferred to the poorest 30% of the population. For bread and rice those figures would only be 18 and 23 cents. Nutritional policies aimed at adequate dietary intake could be conveniently focused around farinha. Such a policy would have a relatively small leakage to more wealthy consumers and would be both cheap and effective.

The second traditional utilization is "aipim" (fresh cassava). "Aipim" consumption levels are under extreme pressure because of the exorbitant marketing margins that are charged (over 80%). For fresh cassava to play a larger role as a secondary staple or vegetable, it is necessary to diminish these marketing margins. The introduction of storage techniques, which might have an additional effect on "aipim" quality, will be critical for increased fresh consumption.

The third utilization of cassava in Brazil is as starch. Cassava starch is easily interchangeable with maize or sorghum starch and its competitiveness depends mainly on the price/quality relation at which it can be supplied to the market. Since 65% of starch production costs are for raw material, the reduction of production costs becomes the critical factor. At the same time, ways in which costs of processing can be diminished or ways in which quality of the final product can be improved should be evaluated.

The fourth utilization is for onfarm animal feeding. It can be safely stated that the utilization potential for onfarm cattle and swine feeding in Brazil is immense. Realization of this potential is dependent on further reduction of costs of production, together with improved storage and feeding systems. Silage systems, such as at present developed in Mexico, might have special value for this purpose.

Apart from the existing end uses, the development of dried cassava production for animal feed purposes has great potential. Present production costs already allow the introduction of dried cassava in animal feed rations, but with improved production technology the benefits of dried cassava to both producers and consumers are going to be enormous. A dried cassava industry would diminish the need to import maize, would stabilize cassava onfarm prices and would greatly extend the market size for the crop. A rough estimate suggests that in the northeast alone around 3.5 million tons of cassava per year could be used in animal feed.

The variety of end uses and the strong differences between the regions of the country allow and necessitate the development of specific regional cassava programs. As far as the north is concerned, it is expected that cassava will maintain its role as a settler's crop. Appropriate development of cassava hinges on striking the right balance between ecological considerations such as yield sustainment and minimal erosion, and the colonist's anxiety for land. In the north settlers occupy large areas of land, often more than 100 hectares per farm. The intensive cultivation of cassava could decrease minimum farm sizes and reduce the rate of frontier movement.

In the northeast, cassava development should be directed towards the creation of a dual market system. For the coming decade, farinha will stay the most important utilization of the crop and a strong effort should be made to maintain its critical role in the northeast diet. Nevertheless, in an environment of continuing urbanization and wheat subsidies, its market prospects are not expansive. Since the small farmer in this region is dependent on cassava, the opening up of the animal feed market will be highly beneficial for his earning capacity. Apart from the development and extension of cassava drying and industrial marketing systems, the success of this alternative market outlet will be greatly determined by the degree to which production costs are decreased. Since reduced production costs are also essential for the maintenance of farinha consumption, this implies that there is a basis for developing a strategy for both farinha and animal feed production development.

The southeast of Brazil has the most complicated utilization pattern, with farinha, starch, fresh cassava, and onfarm feeding existing simultaneously. The starch market appears to have good prospectives for income, market development, and competitiveness reasons. Further development of it will depend on reducing production costs, basically by increasing the relatively low-yield levels of the region.

In southern Brazil, the dominate cassava market is for cassava as an onfarm animal feed. Enhancing cassava's role in this burgeoning market segment depends on a further decrease in production costs. These are already low, but might be reduced by the introduction of improved genetic material. Increasing cassava's importance for onfarm feeding would be an indirect means of increasing protein availability in urban and rural diets as well as farmers' incomes.

In the south fresh cassava consumption is higher than in any other region. The introduction of storage methods would allow fresh cassava consumption to stabilize itself or increase above present levels. This, in turn, will improve its role as an income source for urban-oriented fresh vegetable producers.

It is clear from the analysis described previously that cassava will have a prominent role in the agricultural sector of Brazil. The ability of cassava to substitute for feed grain imports, to supply calories to the poorest strata of society, to provide incomes and steady cash flows to small farmers with marginal land resources, and to provide semi-industrial employment in processing activities will convert the crop into an efficient agricultural policy instrument. The present political situation, in which a newly established democratic government tries to direct its policies more to the welfare of the overall electorate, provides the best opportunity of the last thirty years for cassava to contribute to balanced economic development of this South American giant. Appropriate inclusion of cassava in its development plans will surely guarantee the consolidation of Brazil's first place in the world's cassava league.

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COLOMBIA: POTENTIAL DEMAND FOR CASSAVA

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Macroeconomic Policy and Agriculture

This section focuses on the various economic aspects that have influenced resource allocation in Colombia, particularly between the agricultural sector and the rest of the economy (in a macro context) and within the agricultural sector during the past two decades. The analysis of the set of policies applied should contribute to the understanding of the role that the food and fiber sector have played in the development of the country, how that role has evolved, and more importantly how it is likely to evolve in a near future. Once we reach an understanding of this participation, we will focus on the role of cassava and its products and their potential demand in the near future. Potential demand will be determined by focusing on the consumption of carbohydrates by humans, for which cassava plays a basic role, and on the market for meats where cassava can be incorporated as a source of energy in feed rations.

Economic policy context

The Colombian economy has experienced stable and rapid growth since the mid-1950s. This growth has had as its platform, the performance of the agricultural sector which contributes nearly a quarter of the gross domestic product (GDP) (Table 1), close to two-thirds of export earnings (mainly from coffee) and one-third of total employment in the economy. Agriculture's share in GDP is twice as high in Colombia as it is for Latin America and the Caribbean (LAC) region. Overall, Colombia's per capita GDP for 1985 was US$1,243 (15 among 25 LAC countries, Table 2).

Real GDP grew at an annual rate of 4.2% from 1964 to 1967, 6.4% from 1967 to 1974, and at 5.3% from 1975 to 1980, only to slow down in to 1.9% from 1981 to 1985. This growth was accompanied by rates of growth of 2.8%, 4.7%, 4.1% and 1.4% for the agricultural sector, respectively. Population growth was around 2.1% per year in the period 1965-85, and has since decreased to about 1.5% per year. Urban population accounts for 70% of the total. International reserves were US$3 billion at the end of 1986. For this same year, exports are calculated to reach US$4.5 billion and imports around US$4 billion.

The policy environment

In broad terms, Colombia has striven for food self-sufficiency. Out of 12 items that supply about two-thirds of the protein and calorie requirements of the population, almost all were produced internally (Garcia, 1983). The country went from an import substituting policy to an export promotion policy in 1967 (Decreto 444). A continuous devaluation policy (crawling peg) was adopted, improving the terms of trade by reducing the overvaluation of the Colombian peso. Total exports grew at an annual rate of 4.6% in the period 1970-75, 12.0% in 1976-80, and decreased by -5.4% in 1981-83 while agricultural exports grew at 2.0%, 13.8% and 2.8% in those years.